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Engineering News-Record

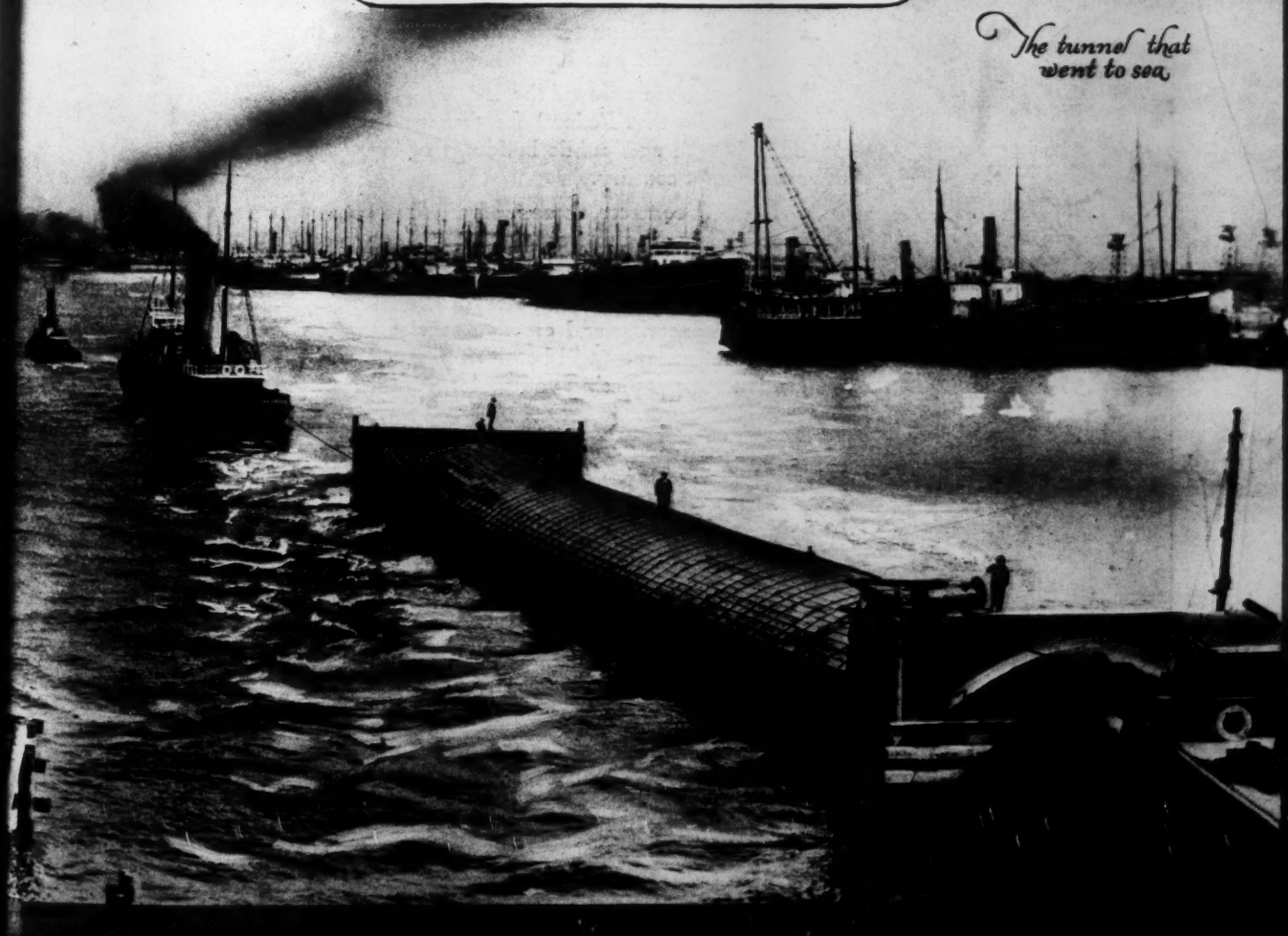
The Civil Engineer in Industry - II
Executive Engineering

Oakland Estuary Tube of 37-Ft. Diameter Built of Precast Concrete Sections

Report on Milan Session of International Road Congress

Electric Coal-Car Dumper Handles 120-Ton Carloads

The tunnel that went to sea



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Qualities Rarely Combined

ONE of the few views on engineering education that practicing engineers consistently hold is that the technical schools would be greatly improved if they could draw on the practicing profession for directors and instructors. It is a view that has not been too well proved in practice, for more often than not the engineer drawn from the field to teach lacks enough of the science of pedagogics and the all-necessary sympathy with youth to offset his superior knowledge of engineering essentials. In Dr. Alexander C. Humphreys, who is retiring from the head of Stevens Institute after twenty-five years conspicuous success as an educator, the common view is upheld. He was and is one of the leading utility engineers in the country, particularly in the field of gas production that he long ago made his own, and he brought to Stevens a breath of practicality too often absent from our schools. But at the same time he had sound views on education and an appreciation of the shortcomings of those who would be engineers. The combination, rare indeed, has resulted so successfully at Stevens that it justifies the belief that when it can be found it goes far toward solving one of the major problems of engineering education.

Making Colleges Pay

SPEAKING on Founder's Day at Lehigh University early this month William C. Dickerman, of the American Car & Foundry Co., put forward a rather new idea in university financing. University and college costs, he reminded his hearers, are increasing at far greater rapidity than income, whether that be from appropriation or from endowment. In consequence we are confronted with a continual series of drives for funds, which are directed toward graduate and philanthropist and which are becoming equally offensive to both. More of our youth demand higher education, and they expect to get it at a fraction of what it costs. How much longer, Mr. Dickerman asks, must the community continue to make up this deficit in the expectation that the expenditure will be returned in community benefit? Should not the individual who benefits from a college education reasonably be expected to bear a greater proportion of the burden of cost? Or if this is tending too much toward an aristocracy by opening the wider realms of learning and practice only to sons of the rich, should we not apply to higher education some of the principles of industrialism? Can we not restrain competition, promote specialization and improve quality in our colleges, and especially in our technical schools, to the degree that they indeed become self supporting, as a commercial enterprise is self-supporting, and therefore fields for financial investment, where returns are in actual money as well as in the more sentimental dividends that now they pay?

Rare But Not Unique Tunnel Building

BUILDING a tunnel in sections floated out and sunk into place is not a novelty. Nearly twenty years ago this method was adopted for the railroad crossing under the Detroit River and for the Metropolitan subway crossing under the Seine at Paris and some years later for the Lexington Ave. subway crossing of the Harlem River at New York. The Oakland Estuary, described in this issue, differs from the earlier types mainly in the choice of material. All of the other big caisson-tunnels were of steel frame and therefore required a certain amount of underwater concreting to complete the structure. So far as the test of time has shown this concreting was satisfactory and the structures so built are adequately serving their purpose. It is well-known, however, that concrete placed in air and properly cured before being submerged has better prospects of life than concrete placed below water and subject to the many possibilities of insufficiency that process involves. The precast tubes of the Oakland tunnel are unique as well as superior for this kind of structure. Making the caisson sections involved no particular difficulty, but getting them into place is an exceptionally delicate construction operation, the completion of which will be looked to with interest. This type of tunnel has its advantages, among which is low cost, if the prediction as to relative costs on the now abandoned Narrows tunnel at New York is any gage. The economic and structural success of the Oakland tube will therefore weigh much in the consideration of the type for future use.

Holland Tunnel Freight

MORE than ordinary significance is attached to the Interstate Commerce Commission's authorization of the Lackawanna railroad's proposal to build a large freight terminal with necessary track extension in Jersey City reported last week. The Lackawanna in common with other roads has needed for some time large additions to its Jersey shore facilities for handling freight to and from Manhattan Island. Its decision to locate the first of these new additions within easy access of the New Jersey portals of the Holland tunnel places on record one large transportation company's views as to the value of the tunnel as a freight artery. It seems altogether possible that the construction of this terminal, of feeder highways such as New Jersey is now building and of other similar facilities may so expedite trans-Hudson freight handling that the Holland tunnel will be operating at capacity long before the period originally estimated. Indeed it is not beyond the bounds of possibility that it will become necessary to limit passenger car traffic to certain hours of the day in order to permit slow-moving haulage traffic to use both lanes of travel. We even may hear in a few years of the Holland *freight* vehicle tunnel.

Learning from Europe

IMMEDIATELY following this note is an editorial comment on European road practice as revealed in the papers presented at the recent meeting of the International Road Congress at Milan. Since that was written the admirable report by Thomas H. Macdonald, the head of our federal roadbuilding activities, was received and is printed beginning on p. 700 of this issue. Mr. Macdonald's comments on the difference between American and European roadbuilding methods are particularly illuminating and should be read by every American highway engineer. Americans are freely accused by our European critics of being too self-sufficient and, in so far as our reading of European literature is concerned, Mr. Macdonald concurs in this view. But he does point out that roadbuilding in this country has reached a development far ahead of Europe and has problems that are unknown there. We can learn from them, but we have to seek far to find the direct application of their practice to ours.

European Concrete Road Building

REPORTS on concrete roads by the European delegates to the international road congress recently held at Milan, as they are summarized in this issue, disclose thought and practices quite strange to American road builders, curiously combined with interesting evidence of the penetration of American ideas in slab and joint design and, less notably, American methods of machine construction. Of all the European practices, perhaps the most queer, to road builders of the United States, is the consideration which is given to "patented" concretes. There are in particular two of these concretes—known as Rhoubenite and Soliditit—which have gained, as it appears to Americans, strange favor.

As described Rhoubenite and Soliditit are exceptionally well-proportioned concrete mixtures one of which contains a powder called Houben and the other of which employs an especially compounded hydraulic cement. Besides the careful proportioning, the proprietary companies which lay these pavements employ very precise construction methods. It is testified that these patented concretes make good pavements. The fact may not be gainsaid. One feels, however, that the reason given by the French expert Feret is the true one: That the same care in proportioning and construction would give equally good results using only the standard portland cements. It is certainly American experience that not medication of concrete but good concrete fabrication, makes a good pavement.

To the American road engineer, too, the sensitiveness of the continental European road builder to cracking in concrete roads and his efforts to avoid it by many joints and by alternate-slab construction appears a little frantic. Certainly cracks are not structurally desirable and pavements "striped like a zebra," as Mr. Feret picturesquely puts it, with tar crack filler, are not sightly, but as long as they stand up and ride well, which Mr. Feret candidly concedes they do, the cracking may not wisely be permitted to be too disconcerting.

Many European countries are feeling their way toward a concrete road construction practice which particularly fits their conditions, one of which is that expenditures must be jealously restricted. Thus we find in all the continental road departments active research looking toward thinner slabs and the possibilities of adapting the slag and natural cements, which are less in price than portland, to concrete road construction. It is this search for economy in cost, one can imagine, which has led to the favor with which the American thick-edge, thin-center pavement section has been received. In this connection incidentally, it is interesting to note how closely the two Scandinavian nations making reports are working to the latest American standards in pavement sections.

To Insure Responsible Contractors

IT is freely admitted that responsibility of the contractor is the most necessary thing that must be made certain prior to the letting of a contract if all of the undoubted advantages of the contract system of construction are to be preserved. Just how that responsibility is to be insured is subject to question. Numerous suggestions have been made and the major purpose of the Associated General Contractors is directed to this end. It is manifest that no single solution is possible, but that the raising of the standards of the contractors themselves, a revision of the practices of contract surety bonding and a better appreciation of their obligations by contract letting bodies all play their part. In the latter development an attempt by a well-known consulting engineer to take over some control of the contract letting is of interest.

This engineer has had numerous experiences where he knew that a given low bidder was not of the type that would reasonably be expected to carry out a projected work to the satisfaction of the government body that was having the work done but he has found that the authorities were not willing to abide by his conclusions. He has felt that his ethical obligations were such that he could do nothing but report his conclusions as to the prospective successful bidder and then, if the authorities persisted in letting the work to that bidder, go on with the supervision of construction as best he could. He believes, therefore, that it would be better to state his position in advance and so word his contract with the city as to make it possible for him to withdraw, with honor, in case his judgment as to the contractor is not followed. He has, therefore, in certain cases inserted the following clause in his contract:

> "The engineer shall make an investigation of the history, reputation, organization and capacity for satisfactory and faithful performance of work of a similar character, of all bidders for the whole or any part of the work and shall certify to the city such of them as may be found qualified and experienced successfully to perform the work. The city shall select the successful bidder or bidders from those thus certified as qualified by the engineer."

If the city does not choose to follow the engineer's advice in regard to a possible contractor, way is thus left for the engineer's retirement, on the ground that his contract has been violated. It takes some courage for an engineer thus to give up an engagement which presumably he sought and which is profitable to him, but it does insure an expert surveillance of the responsibility of the contractor by one who is anxious to assure the best of work. It may, on the other hand, put too much power in the engineer, though not more really than there is put by the authority which he exercises over the conduct of the contract after it is let.

At any rate the scheme is novel enough to warrant some discussion of its practicability.

More Water for New York City Imperative

WHEN a city attains a population of six millions and promises to double its size in a few decades its engineering problems take on large proportions. None of these is more vital than water supply. Not to meet this need spells disaster. New York, which in population is the second city in the world, and in water consumption would be far in the lead did not Chicago use and waste so much, after having been engaged for years past in adding 600 m.g.d. from the Catskill Mountain area to its Croton supply, must lose no time in starting on still another huge project or it will be menaced with water shortage.

This danger has been foreseen by the Board of Water Supply; and so, while still at work on the completion of the Catskill project, its engineers have studied all the physically available additional sources, rejected those too deeply involved in probable legal controversy because of interstate complications, and recommended a plan to give the city 434 m.g.d. from the string of counties between the Hudson River and the Connecticut and Massachusetts boundaries, extending from the upper end of the present Croton gathering ground north almost to Troy. That there is no time to be lost before getting this project under way is shown by the report abstracted on p. 670 of our last issue. Even assuming that recent annual consumption increase is not exceeded, the demand will equal the safe yield of all the present sources combined, with its huge total of 1,100 m.g.d., by 1935.

The layman might ask why this hand-to-mouth condition, which goes back to the latest additions to the Croton system, antedating work on the Catskill supply. The race between water consumption and water-supply capacity is not peculiar to New York City. It is being run in Boston, Philadelphia, Chicago, St. Louis, and Los Angeles, the latter city turning now to the Colorado shortly after completing its long aqueduct from the high Sierras. Nor is this race confined to water supply. Sewers, paving, transit, schools, all are involved. It is a concomitant of city growth. With so many pressing demands and without more comprehensive long-time planning for all of them, most of our cities are always close to the margin of their water-supply and other constructional needs. In the present case of more water for New York City, it may well be that uncertainty as to going to the Delaware, commented on in what follows, has delayed the announcement of a plan for an additional water supply.

Additional meters would cut waste but, as Mr. Merriman points out in his report, New York City already has a reasonably low water consumption, especially considering its large commuting day-time population. The 1925 figure was 139 gal. per capita. True, only 26 per cent of the New York connections are metered, but presumably these are the ones most essential to keeping consumption at a reasonable figure. The main point is, as Mr. Merriman states, that when dealing with such huge water demands, additional meters in New York City would have relatively little effect.

The new project is dependent, as is the full and safest utilization of the present Catskill supply, upon a second pressure delivery tunnel from the Hill View equalizing reservoir of the Catskill system through Manhattan, under the East River and to Brooklyn. The first delivery tunnel was one of the greatest contributions to water-supply engineering afforded by the Catskill project. Such a tunnel takes the place of many lines of pipe, reduces leakage and friction and increases safety, in addition to its other economies. It is to be hoped that the Board of Estimate acts without further delay on the recommendation for the second delivery tunnel which has been before it almost two years.

In passing to our concluding paragraphs a few words may be said as to the allegations, on Monday of this week, in the New York *Herald-Tribune*, headed "Ashokan Water Ample, But Leaks Drain City's $160,000,000 Reservoir." In our current News Section, official statements as to rainfall, runoff and alleged seepage are given. Coming at the beginning of the last week in an election struggle of unusual intensity, these allegations need to be considered accordingly, as is evidenced by the headline announcement that the Ashokan reservoir cost $160,000,000, which in round numbers is really the cost of not only the Ashokan reservoir but also the Catskill aqueduct, Kensico and Hill View reservoirs and accessories. But the need for more water is based on a 600-m.g.d. supply from this reservoir so that were the allegations as to leakage true the additional supply now planned would be more than ever needed.

We have reserved for discussion to the last what to some may be a matter of surprise if not of sharp criticism. Why does not the new plan propose a supply from the Delaware River? That the city would go there next in its reaching out for water many have taken for granted—perhaps, until lately, the Board of Water Supply and its able engineers. Those who have watched the delays of the proposed Delaware River compact between New York, New Jersey and Pennsylvania will not be surprised to learn that the present plan is based on the area chosen, which, like the streams to be tapped, is wholly in the State of New York. Over three years of delay having passed with two of the three states still holding up the proposed compact, no wonder the New York Board of Water Supply turns away from the Delaware. But in view of the fact that the plan proposed will meet the needs of New York only until a little after the construction program is completed, and will make a third of the present Croton supply available at a higher head, the Delaware may well be held in reserve.

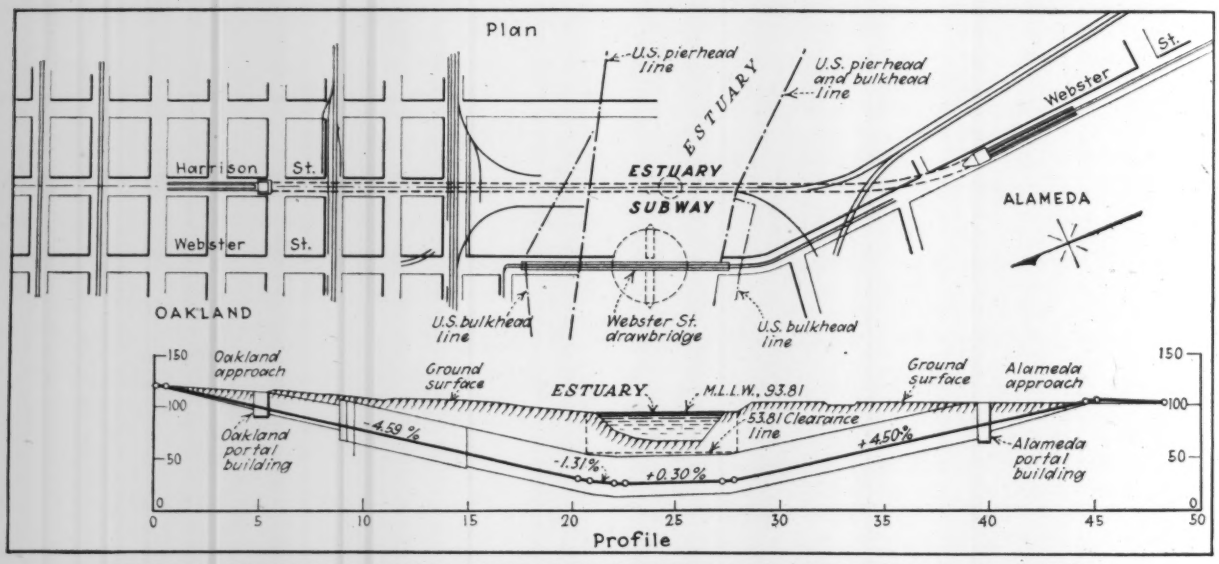
Ultimately the three states must come to an agreement on the utilization of the Delaware—or else suffer. A stream with such great possibilities for water supply and water power and a logical if not an imperatively needed source of water supply for Philadelphia, the New Jersey Metropolitan district and New York City should not much longer be withheld from use because of interstate rivalries—plus the attempts of private water supply and water power companies to look after what they consider to be their own interests.

When the future water demands of Philadelphia, Trenton, Camden, the rapidly growing cities and towns in Northeastern New Jersey, Greater New York and its neighbors within its own state are surveyed even hurriedly, the sum total of water demands seems almost appalling. But the competent engineer knows that there is water and to spare and that he can design and build works to deliver it wherever needed, at a cost easily borne, if only the rival demands of states and cities and a host of private interests can be harmonized and curbed. This is the great problem, one that must be met and solved. Wise statesmanship and good engineering are the necessary factors.

Novel Design and Construction Features of Estuary Tunnel at Oakland

Plan Calls for Twelve Precast Concrete Cylinders, 203 Ft. Long and 37 Ft. in Diameter, to Be Floated to Place, Sunk and Connected Under Water—Using Drydock for Building Sections Avoids Launching

THE TUNNEL under the estuary between Oakland and Alameda, Calif., which is now well along toward completion, was planned to provide a much needed improvement in the direct crossing of the estuary between the two cities, a need that was long served by the Webster Street swing bridge built in 1895. This bridge was condemned by the War Department in 1916 but the removal order was stayed, first on account of the war and later to permit of completion of the tube. A bond issue of $4,496,000 for the tube was approved by Alameda County voters, May 8, 1923, and on March 25, 1926, a contract for $3,882,958 was awarded to the California Bridge & Tunnel Co. for the construction of a tube with a roadway 24 ft. wide designed for vehicular traffic and including two streetcar tracks. The original design and plan of construction was announced in *Engineering News-Record*, Oct. 30, 1924, p. 720, and this scheme is still followed, although further study of design and construction of the subaqueous sections resulted in some changes in details. The segments were built in drydock at Hunters Point on the San Francisco side of the bay and towed seven miles to the site of the tube.



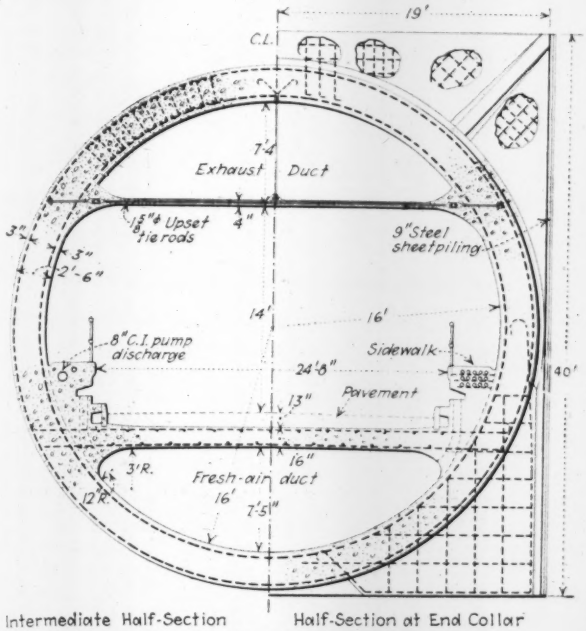
PLAN AND PROFILE OF VEHICULAR TUBE UNDER ESTUARY BETWEEN OAKLAND AND ALAMEDA

Interest attaches to the work because of the lack of precedent in floating to place, sinking to "grade piers" and subaqueous joining of the large precast concrete segments that make up the tube proper. The walls of the tube are 30 in. thick and the outside diameter is 37 ft. as compared to 29½ ft. in the Holland tunnel under the Hudson River at New York.

Progress on the construction of the subway reported by the chief engineer Oct. 20 was: Three of the segments, *L*, *K* and *J*, have been bulkheaded and towed across the bay to the site of the work. Segment *L*, the one joining the Alameda portal building, has been lowered to place successfully and practically all of the sand foundation beneath it has been put in. Segments *K* and *J* are floating in the dredged channel and are being loaded with sand preparatory to sinking.

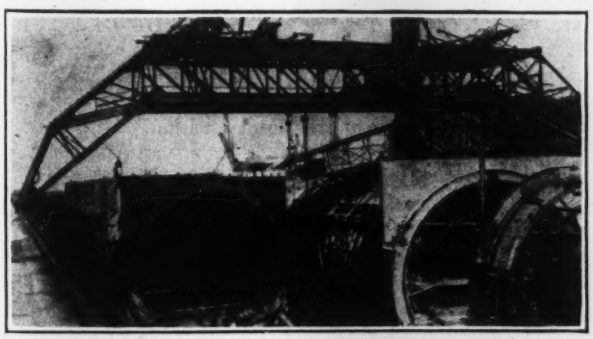
Design and Scheme of Construction—In general the scheme is to make the approach section on each bank in open cut as far as the portal house where ventilating equipment is housed and whence the tube section proper dips down under the estuary channel. The tube is to be made up of 12 precast concrete segments poured in a drydock and floated to place with temporary bulkheads in the ends to make them buoyant, the first plan being changed to omit the ribs or projections on the lower half of the segments. The smooth, cylindrical surface between the collars at either end which was secured in this way made it possible to get a much more satisfactory job of waterproofing. Another important change is that in placing the segments instead of having four lowering barges, one at each corner, more accurate control of the buoyancy has been worked out by loading each segment with sand and water to make it slightly heavier than the water displaced. With this plan it is believed that the weight of the submerged segments can be made less than 50 tons. Thus the two 150-ton derrick barges in attendance will have more than ample capacity to make necessary adjustments in position.

The first step in preparing the foundations was to dredge a trench across the estuary to the required width and depth, with side slopes of about 1 to 1. Except near the south bank the entire length of this trench is in hard clay which would stand under water on almost vertical slopes. For about 400 ft. of the south end where soft mud was encountered a pile foundation was



SECTION OF TUBE SHOWING DIMENSIONS

needed. Transverse rows of piling were accordingly driven 4 ft. to 8 ft. apart and a layer of crushed rock was then dumped along the bottom and sides, bringing them up to grade and forming a cradle for the pipe; the layer of rock required for this varied from 2 to 6 ft. in thickness. A 3-ft. layer of concrete was then placed with tremies on the bottom of the trench. On top of this and braced against the outer side of the first row of piles on either side above the bottom, longitudinal lines of steel plates with edges stiffened by angles were placed as retaining walls for the toe of the concrete slabs poured on the slopes. These slabs, also poured with tremies, are 3 ft. thick and extend up the slopes beyond the width of the tube. This tremie concrete was continued throughout the length of the trench, providing a concrete lining much like a groove or continuous cradle, 3 ft. below the under surface of



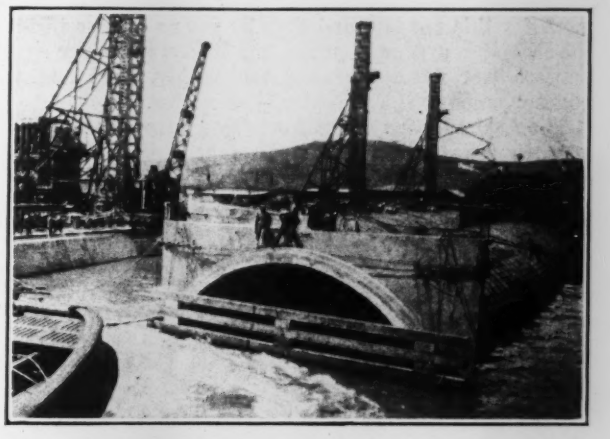
SEGMENTS UNDER CONSTRUCTION IN DRYDOCK

Note limited clearance between adjacent segments. V-shaped recess in crown is to fit corresponding projection on next segment as guide in placing.

the tube. The 3-ft. sand cushion pumped into this space was designed to afford the tube a uniform bearing on the concreted bottom and sides of the trench.

Four concrete grade piers, 6½ ft. in diameter, were provided for each segment to mark the line and grade at which the segments were to be located and also to serve as temporary supports for the segments until the sand cushion was placed. A pair of these piers was located 5 ft. 9 in. back of the end of each segment and poured in the dry within steel cylinders, 7½ ft. in diameter. These cylinders were driven with a hammer to a satisfactory foundation and after the concrete had been poured the cylinders were pulled to be used again. The height of the grade piers ranged from 8 to 12 ft.

Sand boxes are used on the tops of the grade piers so that the support they afford temporarily can be entirely removed when the sand cushion is in place. The sand boxes consist of two parts with provision for sluicing out sand from between to permit the upper part, weighing about 2 tons, to settle 6 in., telescoping by this amount into the lower part. The sand cushion beneath the tube is confined on all sides and is not subject to scour or other current action—it will not compact or settle more than a fraction of an inch after taking the load of the tube filled with water. The

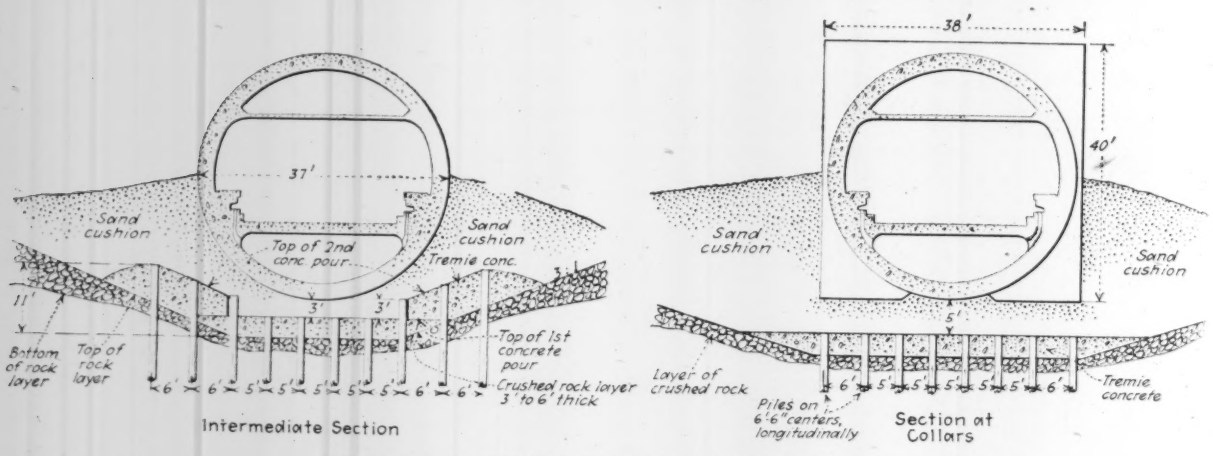


LOWERING FIRST TUBE SEGMENT OUT OF DRYDOCK

lowering of the sand boxes is therefore expected to leave the weight of the tube resting uniformly on the sand cushion throughout its length.

Tests were made with the sand boxes to determine the most effective means of removing the sand under load, as the result of which some changes were made in the arrangement of pipes. It was found necessary to agitate the sand by water jets and accordingly two ½-in. pipes were led about 12 in. into the sand box at one end, through which a water pressure of 75 lb. per sq.in. was introduced. The boxes have 2-in. inlet and outlet pipes and to the latter is attached the suction end of a centrifugal pump. In order to prevent this pump from being choked with a rush of sand at the start it was found necessary to get the pump operating with clear water before opening the suction into the sand box. It was also found that the sand would pack and could be removed only with difficulty if it was not of uniform quality. Eighty per cent of the sand used in the boxes is required to be graded between 30 and 50 mesh.

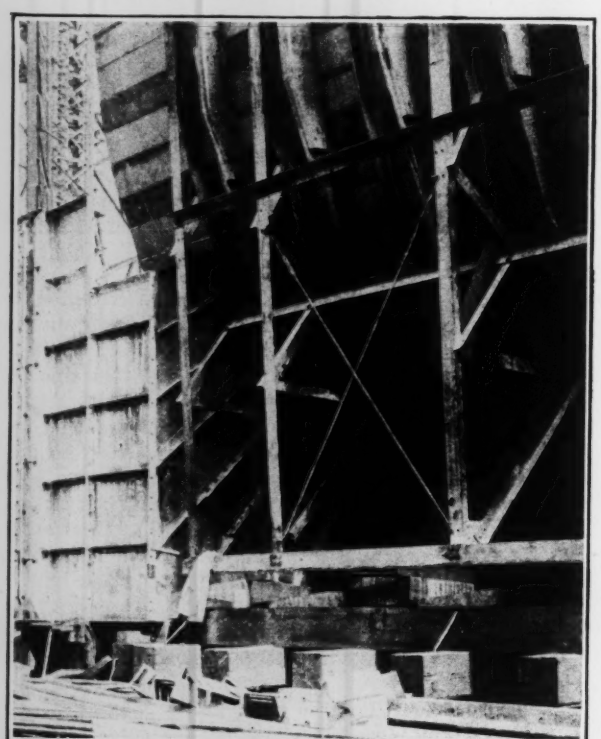
The first segments are being placed on the south bank and the work will progress across the channel to the north. A target is placed on the north end of each segment on a 4-in. mast high enough to leave it above water with the section in place. The elevation of the target above grade is accurately determined before the segment leaves the drydock and this end is used as a guide in location. The procedure when ready to sink the segment is first to place a 4-ft. fill of sand on the floor slab using an opening left in the top of the seg-



SECTIONS SHOWING PILE FOUNDATIONS AT SOUTH END

ment for this purpose and then by means of pipe inside the segment arranged somewhat like a sprinkler system, to wet down the sand thoroughly, thus adding about 50 tons to the weight of the section.

The final addition of ballast is by means of sea-cocks, admitting water to the compartment beneath the floor slab. The ducts and other openings into this ventilating compartment were temporarily made watertight for the sinking operation so that, in tilting out of level, water could not escape into the compartment above. Just enough water is admitted to make the segment heavier than the displaced water. The segments weigh about 5,000 tons with bulkheads in each end and ready to be floated out of the drydock, and in this condition the draft of the first three segments varied between 26 and 27 ft.



SEMICIRCULAR STEEL TRUSSES UNDER FORMS ON LOWER HALF

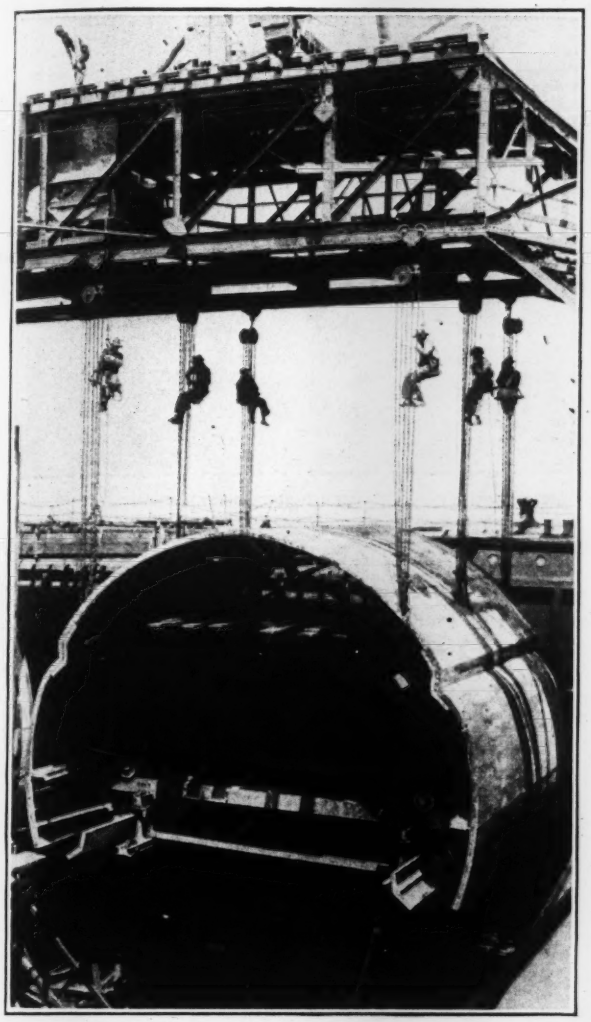
Note timber supports and method of wedging up trusses to grade. At left are forms for projections to rest on grade piers.

With two or more segments satisfactorily placed on the sand boxes of the guide piers some additional water is admitted to make sure of sufficient weight to hold the segments in place and then the sand cushion beneath the segments is pumped in. Sand used for this purpose is brought to the work on barges and a 6-in. centrifugal pump is used for delivery. The sand is put in with the aid of a diver and the endeavor is to give the work the same care as tremie concrete. When the trench has been filled with sand up to the level of the floor slab on both sides the sand boxes on the grade piers are lowered and then the segment is flooded so as to give it its maximum weight.

Before the segments are placed, steel plates about 2 ft. high are fitted into slots in the tops of the grade piers and when the time comes to clear out the joints ready for placing the tremie concrete these plates prevent the sand from moving longitudinally under the segment into the space reserved for the joints. A half-section of steel sheetpiling projecting from the vertical edge of the collar on each segment serves as a guide for one edge of a vertical half-cylinder of steel plate which constitutes an outer wall for the tremie concrete at the joint. Before this concrete is poured a diver takes the suction end of a 6-in. pump into the space thus protected and removes any material that may have come in while placing the sand cushion. The tremie concrete required to fill the 6-ft. space between the collars of two adjoining segments is about 180 cu.yd.

Just before placing the tremie concrete seal between adjoining ends of two segments the diver places in the groove at the abutting ends, so as to overlap both segments, a 12-in. heavy canvas belt. This is to be placed in two halves, the first half on the lower portion of the joint where it can be held in place by fastening the two ends to ropes from above. The upper half is to be held in place by gravity, its ends being tucked under the belt held in place by the rope.

Building the Segments—For use in casting the 12 subaqueous segments the contractor leased for six months the smaller of the two drydocks at Hunters Point on the San Francisco side of the bay about 7 miles from the location for the tube. The lease stipulated a penalty of $1,000 per day for overtime beyond



MOVING AN ARCH FORM SECTION TO NEW SEGMENT
These sections hinge at the crown and have wings on each lower edge that swing inward to permit lowering when form is to be moved.

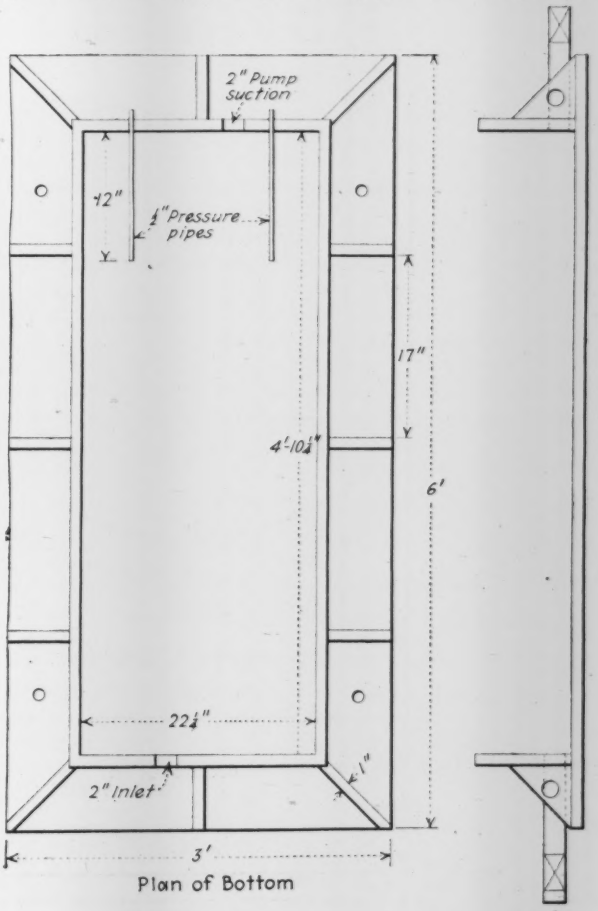
the period specified so that there has been a constant pressure to keep the work up to schedule.

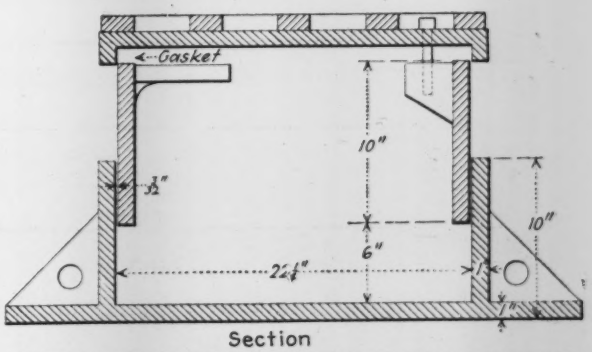
The curved sides of this drydock and the limited floor area made it difficult to get the foundations for the segments laid out to good advantage. The fact that the first three segments built were curved in plan added to the difficulty and limited the capacity of the floor to three segments, although in the remaining space work was begun on part of the fourth segment. Five segments were to be built in the second group in the drydock and four in the last group.

Concrete materials come to the drydock by water, are unloaded by stiff-leg derrick to bunkers whence they go by belt conveyors to stock piles adjoining the mixing plant. A total of about 30,000 cu.yd. of concrete will be required for the 12 segments and is being supplied by two 1-cu.yd. mixers. From the mixers concrete goes in dump cars on a 24-in. railway to any one of three 110-ft. towers whence chutes deliver to all parts of the work. The concrete mix is, approximately, 1:1½:3 to meet specifications calling for at least 8 sacks of cement per cubic yard. Diatomaceous earth is added to the mix in proportion of 1 per cent, by weight, of the cement. Inundators were installed over each mixer but the time required for their operation was such as to materially slow up the production of concrete and their use was discontinued. Moreover, the moisture content of the sand was found to vary but little and very satisfactory results were obtained without the indundation method.

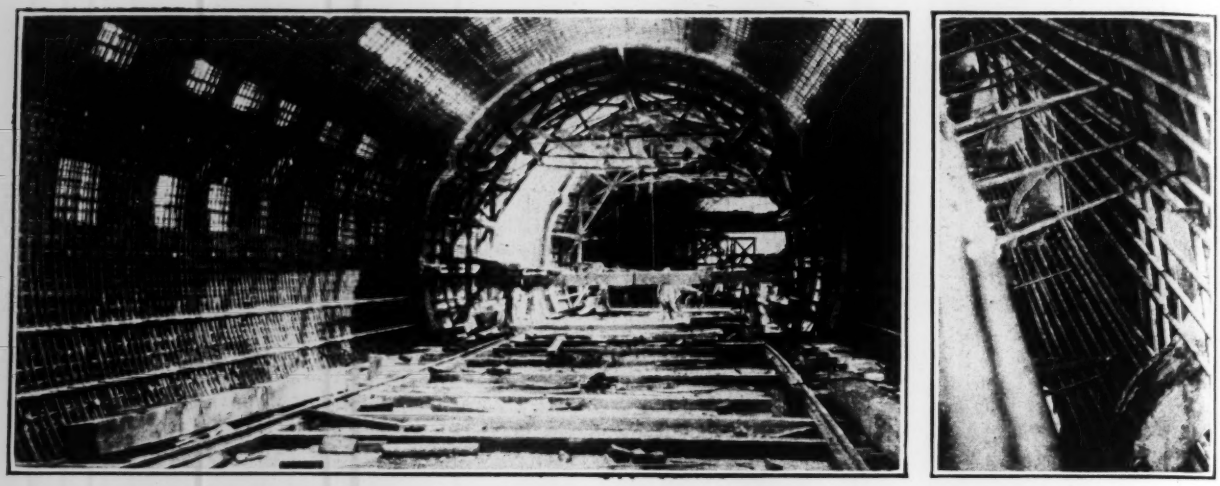
Steel forms and other heavy equipment or materials to be moved into the drydock are handled by a gantry crane which spans the dock on tracks that extend for its entire length. The gantry has a capacity of 60 tons or 20 tons on any one of the three trusses of which it is made up. The rather unusual design of this crane, with inclined trussed end posts, is shown on p. 693.

The drydock, designed solely for vessels of course, has along its center line as a keel support a heavy concrete pier below floor level. The concrete over the remainder of the bottom is only about 18 in. thick, not quite sufficient to carry the weight of the precast





SAND BOXES TO BE SET ON CONCRETE GRADE PIERS



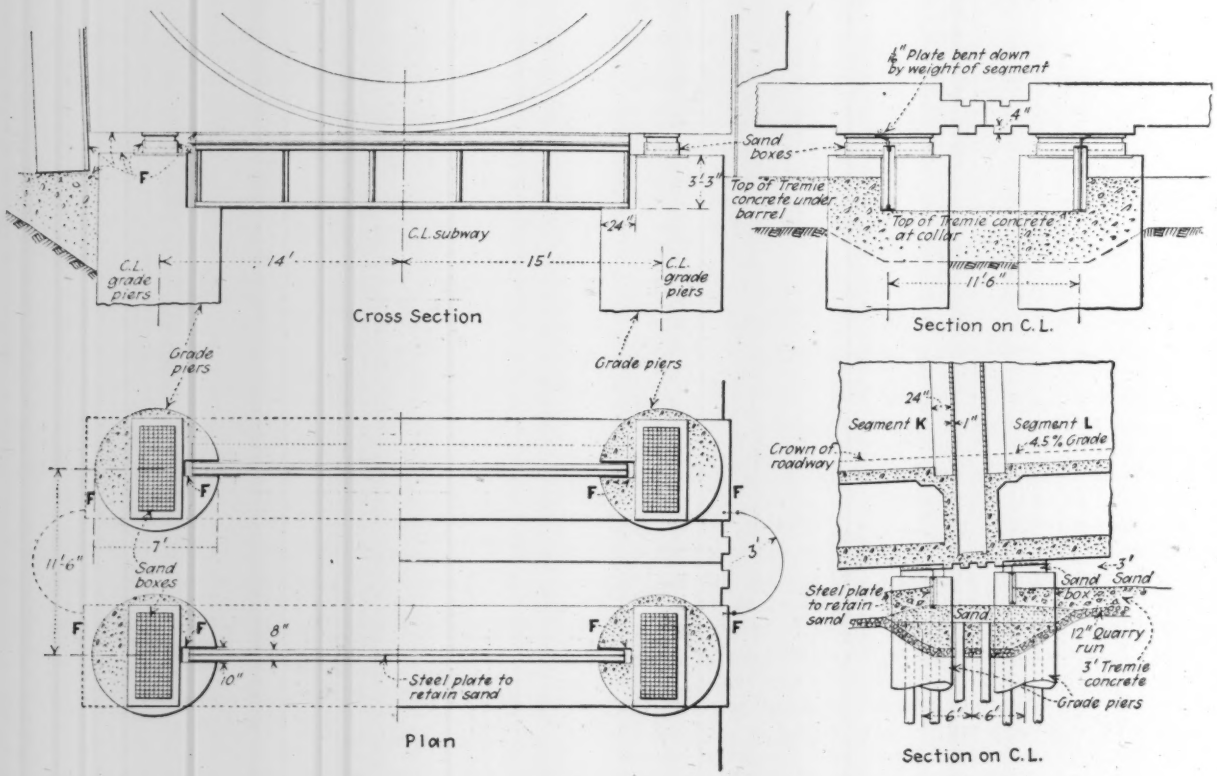
PLACING INSIDE FORMS FOR ARCH OF SEGMENT, AND CONCRETE CHUTING ARRANGEMENT

Through openings in outer forms pours will be made at successive levels. Segment in background nearing completion. The closed, curved chutes for concrete were a great improvement. They prevented the rebound of aggregate by delivering in between the grillages. These chutes are shown in the right-hand picture.

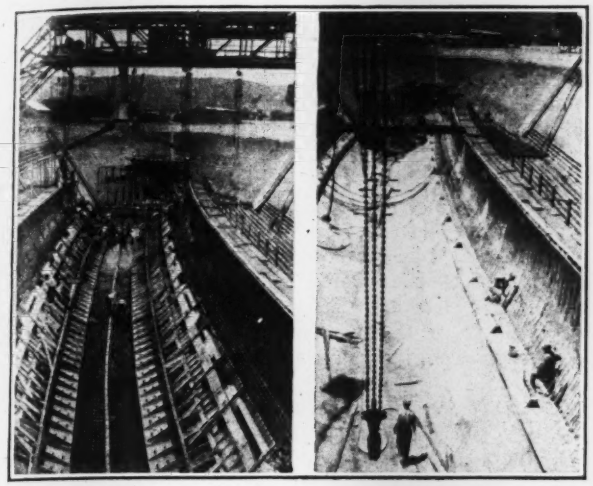
sections. Hence 12x12-in. timbers were laid down on the floor as a foundation on which to place the concrete forms. The 12x12's were accurately spaced and leveled so that they would come under the semicircular steel trusses which support the concrete forms in the lower half of the tube segments. Under the curved segments the timbers were arranged radially to conform to the radial location of the trusses.

These semicircular trusses 6½ ft. apart support all concrete and forms below the horizontal diameter of the segments. On the inside faces of these trusses is a wood nailing strip to which the lagging of 2x12-in. planks can be lightly tacked. On the inside of the lagging is placed a 3-ply waterproofing consisting of impregnated cotton cloth capable of withstanding a pull of 90 lb. per lineal inch. This cloth is embedded in four layers of asphalt mopped on hot, thus finishing the outer surface of the form against which concrete is to be poured.

The steel in the lower half or invert of the segment is then placed and the inner steel forms are jacked into position after which the lower part of the cyl-



DETAILS OF ARRANGEMENT WHERE SEGMENTS JOIN



POURING THE INVERT, AND INVERT READY FOR FLOOR SYSTEM

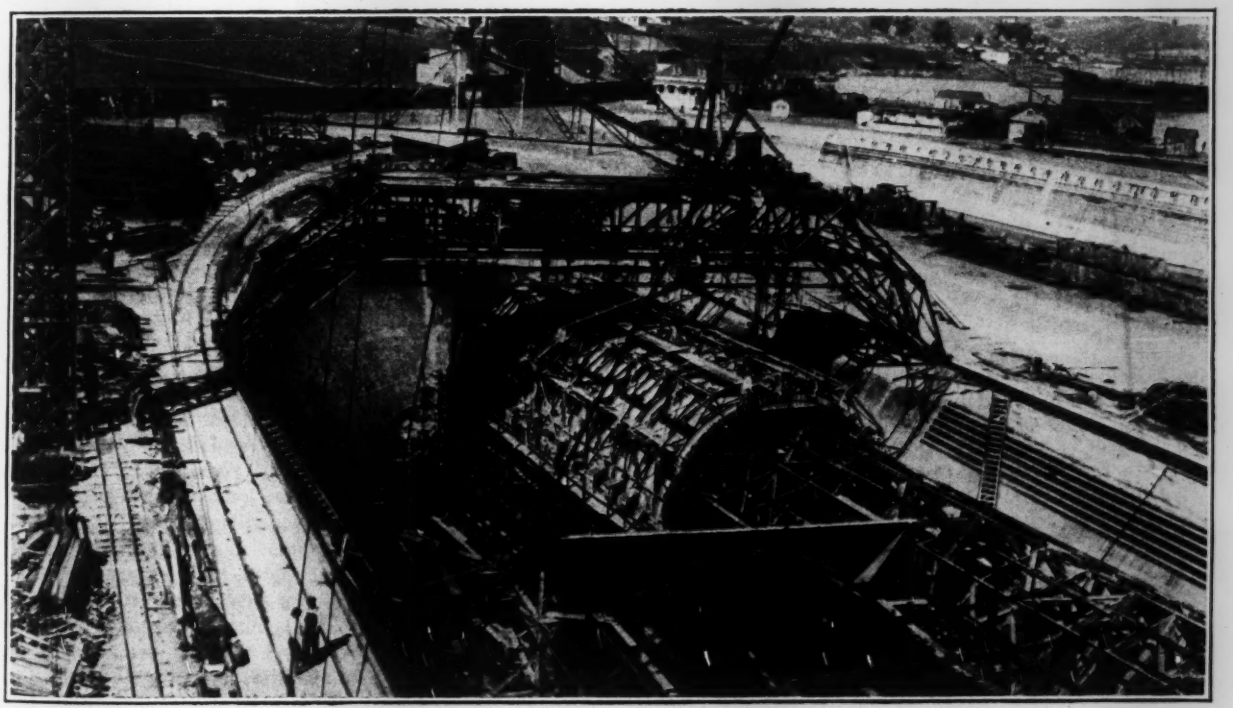
Note concrete distribution scheme. No upper form is used on central portion of invert. Waterproofing may be seen on inside of lagging. White projections at intervals along upper edge of concrete are curved plaster-of-paris forms which will later be dug out leaving smooth ventilation ducts.

indrical shell up to the floor level and containing about 700 cu.yd. is poured in one continuous operation. After a period of three days for setting the floor slab is poured with the use of traveling forms made up into sections about 100 ft. long so that only two set-ups are required for each 203-ft. segment. Excepting only the center support, each pour is given 2 days to set before moving the forms. When the slab floor is old enough to carry load, a wood-frame traveler, 100 ft. long, and hinged at the crown, is placed on the floor and by means of jacks adjusted to position as a guide for placing the reinforcing steel of the upper half or arch.

The outer forms for the upper half of the tube are much the same as those used below except that the curve, of course, is inverted and the steel trusses form an arch. On the under side of the trusses 2-in. planking is used to complete the outer form. Reinforcing steel in the arch is in the form of two grillages of $\frac{3}{4}$ to 1-in. steel bars, one near the outer surface and one near the inner face. The longitudinal bars are spaced on 6-in. centers and circumferential bars on 12-in. centers. The rods are kept $2\frac{1}{2}$ in. from the forms by small concrete blocks wired to the reinforcing on 6-ft. centers each way. The reinforcing is supported and held in place by bolts that fasten it to the trusses above. Concrete is poured through openings left in the planking. After the concrete has set, planks and trusses are removed and then, unlike the procedure in the lower portion, the waterproofing and the timber lagging which is to protect the waterproofing are put on the upper half as a separate finishing operation.

There are thus three separate pours made on each 203-ft. segment in the drydock, the first completes the invert up to the floor line, the second puts in the floor slab and the third, comprising about two-thirds of the cylindrical shell completes the arch. A final or fourth pour which is to be made after the sections are anchored in place in the estuary as a continuous tube, comprises the ceiling or partition wall over the roadway to close it off from the air passageways and the side walls.

Because of the large amount of steel, the very limited clearances in the forms and the difficulty of spading, particularly in the lower portions of the arch, it was not easy to get concrete properly into place even with openings in the forms for pouring at four levels between spring line and crown. This condition was much improved and better concrete resulted, even with only three pouring levels on each side, when "goose-neck funnels" were used to catch the concrete from the ends



TWO SEGMENTS NEARING COMPLETION IN DRYDOCK

Segment in foreground shows waterproofing layer; one in center at stage of concreting arch

of the chutes, lead it through the openings in the forms and direct the flow downward between the inner and outer grillages of reinforcing bars. With this method there was no rebounding of aggregate from reinforcing bars and a minimum of patching with the cement gun after the forms were stripped.

The steel forms for inside and outside of the upper portions of the cylinders are in 21-ft. sections. Each section is hinged at the crown for convenience in moving. Between set-ups the inside forms move along tracks of 24-ft. gage inside the tube and, when spotted in place, vertical jacks raise the crown to grade while others, placed horizontally, force the side walls out and hold them rigidly in the prescribed position. The outer forms are moved to the gantry crane, as are the inner forms in transferring from segment to segment.

TOWING CURVED SECTION TO SITE

The curved sections are to fit a location laid out on a 1,273-ft. radius but inside the tube this curve will be made up of a series of 21-ft. chords. That is, the steel forms are built on straight lines and on the curve the forms will be set at a slight angle to make the desired curve, a wooden filler being put in between the ends of adjacent settings to take up the open space along the outer edge. This filler varies from a feather thickness at the inside of the curve to a width of about 10 or 12 in. on the outside.

The bulkheads in each segment are made of timber, for the most part 12x24's with 23-in. steel I-beams for the deeper segments, placed vertically with tops and bottoms against steel plates embedded in the concrete to which each timber is separately bolted. The timbers are placed against one another to make a solid wall at least 24 in. thick. Over this wall a facing of tongue and groove ceiling is placed horizontally and then a 3-ply waterproofing finish is put on and mopped with asphalt. Finally, as a protection against floating objects that might damage the waterproof coating, a grillage of heavy timber is fastened over the end of the bulkhead.

After the steel forms are removed and the waterproofing and wood lagging are in place, steel rods are placed around the segments and drawn up tightly, much like hoops around a tank to hold the timbers firmly in place; thus as the segments are floated out of the drydock they resemble sections of huge wood-stave pipe.

George A. Posey is chief engineer of the estuary tube project. The board of consulting engineers consists of W. H. Burr, Ole Singstad (successor to Clifford Holland), and Charles Derleth, Jr. Austin W. Earl was engineer in charge of designs. H. E. Squire is advisory engineer, N. D. Baker, office engineer, Lochiel M. King, construction engineer, and Merton C. Collins, ventilating engineer.

Contract for the construction of the estuary tube is held by the California Bridge & Tunnel Co., Bayly Hipkins, chief engineer and construction manager, and A. R. Baker, resident engineer. Francis Betts Smith is consulting engineer for the contractor.

St. Louis Concrete Building Halved in Street Widening Plan

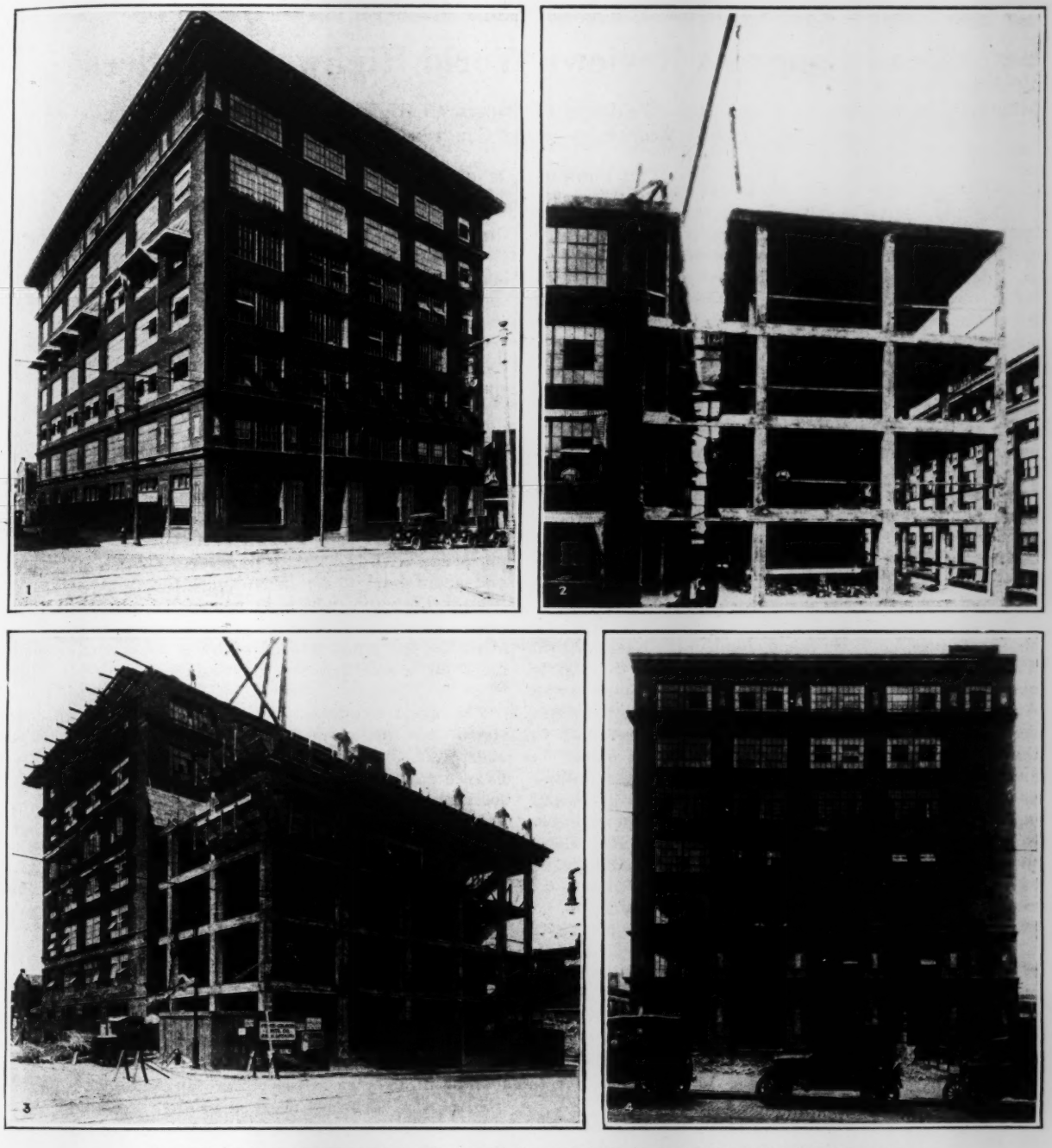
Forty Feet Taken Off of Seven-Story Structure —Demolition Work Occupies Only Seven Days—Old Material Reused

By S. W. Bowen
Engineer, Fruin-Colnon Contracting Co, St. Louis, Mo.

In widening Olive St., Louis, Mo., 40 ft. was taken off the south side. The work involved the reconstruction of a number of buildings, the Lesser-Goldman building at 17th and Olive Sts. being the largest and most modern of those reconstructed. This building is seven stories with basement, and was built about 10 years ago. Previous to its reconstruction it had a frontage of 80 ft. and depth of 109 ft. Thus its depth was, in the reconstruction, reduced to 69 ft. In the reconstruction extensive interior changes were necessary, such as providing new toilet rooms, moving the elevator and stairways and rearranging the interior of the fourth floor.

The first step in the reconstruction was the installation of a stiff-leg derrick on the roof with a boom long enough to reach the two north corners of the building. This derrick was used for the erection of the structural steel and for handling the reinforced-concrete columns as they were demolished. Next, to separate the north 40 ft. of the building from the south portion, a strip about 6 ft. wide was cut out through the roof and each of the floors and the two walls by means of jack-hammers. The north 40 ft. of the building contained the passenger elevator and the stairway and these were not disturbed until removed to their new location. They were used as long as practicable for men and materials during demolition work.

The steel columns, beams and other framework required for the new front of the building were erected on new foundations and the brickwork run up. The demolition of masonry wall filling preceded the construction of the new face and this old brick and steel window sash were used in the reconstructed building face so far as was possible. Upon completion of the new building face the elevator was installed in its new location and demolition of the reinforced-concrete frame



REINFORCED-CONCRETE BUILDING BEFORE, DURING AND AFTER RECONSTRUCTION

Fig. 2 shows the 6-ft. cut made through the entire building. In Fig. 3 note timber screen erected to protect new building face from injury and to keep debris from falling. Fig. 4 shows the new front completed on the new building line.

of the north 40 ft. was started. Floor slabs were broken down with jack-hammers, and the débris fell to the floor below, whence it was shoveled into chutes and carted away. Columns were broken at the floor line and loaded into trucks by the derrick on the roof. Actual work of demolishing the reinforced-concrete framework consumed seven days, of three shifts each. The entire work of reconstructing the building consumed little more than two months.

The general contractor on the work was the Fruin-Colnon Contracting Co., St. Louis, Mo.

New Water and Sewage-Works in Missouri

A survey compiled by the Missouri State Board of Health shows that fifty Missouri municipalities installed new water-works or sewer systems or made improvements to existing systems during 1925. The survey did not include St. Louis or Kansas City. The improvements totaled $2,219,122. Twenty-six of the improvements were financed by bond issues, while tax bills or earnings took care of the balance. Bonds issued for these purposes totaled $1,154,500.

Road Congress Reviews World Highway Practices

International Meeting in Milan, Italy, Featured by Papers on Highway Design and Construction—Lack of Papers on Highway Economics—Next Congress Probably in United States

By Thomas H. MacDonald
Chief, United States Bureau of Public Roads, Washington, D. C.

FIFTY NATIONS of five continents, represented by a registration of some twenty-three hundred delegates, official and unofficial, contributed each its generous share to make the Fifth International Road Congress truly reflect the major position highways are occupying in the whole world's scheme of transport.

This congress, in response to the invitation of the Italian government, met in Milan on Sept. 6, continued there until Sept. 10, then rose to meet in Rome for the final three days' program. With the Duke of Bergamo representing the king, the minister of public works, many high officials of the kingdom, the Italian organizing committee, and the general officers of the association, seated at the president's table and flanked by the military and the Fascisti guards, the formal sessions were opened in the historic Castello Sforzesco before a large assembly of the delegates and visitors.

The final session was held in the National Museum on the Capitoline Hill, Rome, Sept. 14. Here, within a stone's throw of the ancient Forum where the visitor may still walk the Via Sacra which leads out to the Appian Way, Benito Mussolini, head of the government, delivered the closing address in which he referred to the great network of roads possessed by Rome in antiquity. It was a colorful scene, vividly contrasting ancient and modern Italy. The colored uniforms and polished metal helmets of the guard, stationed at intervals from the very foot of the Capitoline Hill along the winding road to the plaza where stands the statue of Marcus Aurelius, made an unforgetable picture as we made our way to the Museum. And inside, as we followed through long corridors, tenanted with busts of figures out of the past, there was always that row of guards, more closely stationed now, to the very door of the assembly hall where, standing beneath a heroic sculptured figure of Pope Pius VI, the head of the government pledged Italy to a program of modern highway improvement based upon the results of the road census and scientific studies.

Meetings in Two Sections—After the first session, for the detailed consideration of the work before the congress, the delegates separated into two sections, each to consider three major subjects. To the first section the general reporters presented their conclusions relating to construction, materials and design, while simultaneously to the second section they presented those pertaining to city planning, traffic census, and the "Autostrade," or roads built and reserved for the exclusive use of the motor vehicle.

In the first section, perhaps the sharpest debate came upon the relative merits of tar and asphalts. In the second section, the most important division of opinion came upon the public policy involved in the granting of franchises to private corporations to build exclusive motor toll roads. An important resolution from the second section called upon the permanent association to establish an international committee to formulate international rules or standards for the traffic census for the purpose of reducing traffic records and measurements to a comparable basis.

To the American delegation perhaps the most welcome of all the attentions which were generously showered upon the delegates by their Italian hosts were the final words of President Luigi Luiggi when he said: "I will not say goodbye but rather, au revoir, until, as I hope, we meet for the next conference in the United States."

Outside the sessions of the Congress the interest of the delegates centered upon the recently completed 50-mile motor road very modern in its conception, connecting Milan with the Lakes Maggiore, Varese, and Como, and upon the Via Appia Antiqua, the Appian Way of Appius Claudius, which is popularly regarded as the most ancient of highways. Between these two, stretches the panorama of highway transport development for more than two thousand years.

The Road Congress Plan—The Permanent International Association of Road Congresses dates back to 1908. The general headquarters are established in France and the president general, Senator Mahieu, and secretary general, Mr. LeGavrian, are French. Each succeeding congress, however, is conducted by an organizing committee of the country issuing the invitation and the Italian committee, headed by Signor Luigi Luiggi, one of Europe's most famous engineers, not only had made excellent preparations for the congress itself but succeeded wonderfully well in expressing to the many-tongued delegates the warmth of Italy's hospitality and cordiality.

The experience gained through former conventions is evident in the methods adopted for bringing order out of the many ideas and reflexes of many differing conditions. All papers submitted are printed some months in advance in the official languages and distributed to the delegates as soon as they are known. In this particular congress the papers were submitted under six major subjects. All papers on each subject were submitted to the organizing committee which referred them to six general reporters, highly qualified engineers of Italy. These six general reporters each digested the various papers on a single major subject and prepared conclusions which were printed in the official languages and distributed to the delegates to be discussed three at each section meeting as previously noted.

United States Papers Most Comprehensive—A full set of papers had been prepared by the engineers of the United States under the leadership of a committee made up of A. B. Fletcher, chairman, Dean A. N. Johnson, H. Eltinge Breed, Walter W. Crosby, and Arthur

W. Dean. These papers constituted the most complete response of any country and they present a noteworthy contribution to the available works on highway engineering and modern highway transport. Many favorable comments were made by the engineers of other countries upon the value of these papers to them. It was evident that authentic material upon highway subjects prepared by the leading highway engineers of the United States received wide attention and the most serious consideration of the engineers of foreign countries.

Somewhat aside from the subject it may be remarked that the engineers of other nationalities are undoubtedly more eager and more conscientious students of the current engineering literature of other countries than is true generally of our own engineers. The conclusions reached by the general reporters reflected a careful consideration of the papers and although some changes were made as these conclusions were presented to the two sections of the Congress, in the main they received a favorable vote and thus became the final conclusions. They may be characterized as a careful but perhaps conservative expression of the best accepted thought and practice in the technique of highway engineering. They may be open to the suggestion that they are based too much upon theory and lack somewhat the practical character of conclusions drawn from broad and long experience.

Lack of Highway Economics' Papers—The very important omission in the program was the disregard of the economic engineering phases. The highway itself was given too much attention. The kind, quality, and quantity of service required or that may be rendered is of greater importance. Also the relationship of highway transport to other transport agencies received no consideration. Looking back upon the experience in the United States, it was the tremendous growth in highway utilization that drove the engineers from the more mechanical aspects to the economic regard of highways and away from debating over the qualities of various types of roads to a struggle to maintain highway service fairly acceptable to the public. Coincidentally the highway administrators find themselves confronted with the necessity of keeping in harmony with other transport agencies, notably the electric and steam railroads, through a respect for the service rendered by them and an acceptance of the limitations of economic highway transport.

The Milan program carried no subjects dealing with these phases which are the inevitable offspring of a tremendous highway traffic. There is no more significant evidence of the great difference that exists between the United States and other countries in the degree of utilization of highway transport. Europe is still regarding the motor vehicle as a luxury rather than a general public utility. European engineers believe the motor vehicle will have a big future but the public does not. So the programs of the conference reflect perhaps the conventional technical aspects rather than the problems which will dominate with the intensive development of highway traffic.

Italy's New Motor Toll Highway—There is no better illustration of the difference in viewpoint between the United States and Italy, for example, than the circumstances of the "Autostrade." Here is a toll road reserved exclusively for motor traffic, built by private capital under state franchise to extend for fifty years. It is laid over an entirely new right-of-way, without intersections at grade, no speed limit, ample width, concrete pavement with bituminous skin coat, easy curves, superelevated. In fact every provision is made for fast traffic between termini. The Italian committee proposed the "Autostrade" as one of the six subjects for discussion before the Congress. As developed by the general reporter, Sr. Isacco, the chief of the Federal Highway Division, the matter presented encompassed both the public policy involved in granting private franchises for toll roads with power to exclude all but motor traffic, and also the engineering conception of the highway itself and its operation.

When this dual aspect was presented to the second division in an interdependent relation, both the English and the United States delegations found themselves in a somewhat embarrassing position. All the traditions of English speaking people demand freedom of the highways. They are opposed to any conception of the highway which involves the exclusion of any kind or type of traffic that may demand service. To them the earliest meaning of the highway was not a physical thing but rather a right—the right to pass. The toll feature is not so foreign to our traditions since toll roads have been somewhat widely used during our past history; but the old method of collecting tolls at toll gates has served its purpose, speaking generally, and is no longer favored. With this common background the English and United States delegations found themselves unable to accept the public policies suggested for general approval.

On the other hand the engineering conception of the plan was courageous and highly representative of the best practice in the design of modern motor roads. Both of the dissenting delegations, undoubtedly, would gladly have complimented and endorsed the engineering conception had this aspect alone been presented. Under the circumstances, the delegations withheld their vote with the expressed hope that at a future conference the benefit of the financial details of the operation over a number of years might be available. This brief discussion does scant justice to a really remarkable development. The conditions are exceptional and while scarcely affording proof of the soundness of the principle of the "Autostrade" for general application, as here worked out the result is one of which the Italian people may well be proud, and they are. The whole project certainly reflects great credit upon those who carried it through.

United States Suggested for Next Meeting — The delegation found a strong sentiment among the delegates for holding the next Congress, probably in the fall of 1929 or spring of 1930, in the United States. At the closing session in Milan a letter was presented to the assembly from the Secretary of Agriculture of the United States expressing the hope that an early meeting of the Congress might be held in the United States and this met with such evident favorable response that President Luigi Luiggi closing the session used the expression quoted above. In addition to the numerous contacts formed throughout the sessions with the delegates from other countries, the United States delegation gave a number of informal luncheons for groups of the delegates and among these the sentiment existing for holding the next Congress in the United States was most encouraging.

European Concrete Road Practices Strange to America

Patented Concretes Find Favor—Steel-Tired Traffic Compels Consideration of Protective Coatings—American Thickened-Edge Section Used in Scandinavia—Light Equipment and Much Hand Work

REPORTS on concrete road practice from six continental European countries, besides those from England and from the United States, were presented at the Milan, Italy, meeting Sept. 7-11, 1926, of the Permanent International Association of Road Congresses. These six reports contain chiefly the differences of design and construction which distinguish European from American practice and which therefore most interest American engineers. They are given greatly condensed under the titles which follow. This supplements the report by Mr. MacDonald on p. 700.

* * *

Bituminous Carpets Essential Feature of Dutch Roads

By L. R. Wentholt
Chief Engineer, Rijkswaterstaat, Nijmegen, Holland

IN connection with the construction of the Meuse-Waal canal 22 km. (13.64 m.) of new roads had to be built. Concrete was adopted. As extensive road improvements are to be carried out in Holland it was judged of the highest importance to build these concrete roads as cheaply as possible. By this means experience would be gained on a large scale in the construction of low-priced road surfaces. Therefore the concrete was not provided with reinforcement. As, however, horse-drawn carts with metal-rimmed wheels are still very much used, the roads were coated with a thin bituminous dressing, consisting of a layer of spramex with gravel.

This bituminous dressing renders it possible to use unprotected expansion joints, if the joints are so near each other and are so narrow that the carpet is strong enough to bridge them. This is one of the reasons why the distance apart of the joints is made not greater than 4 m.

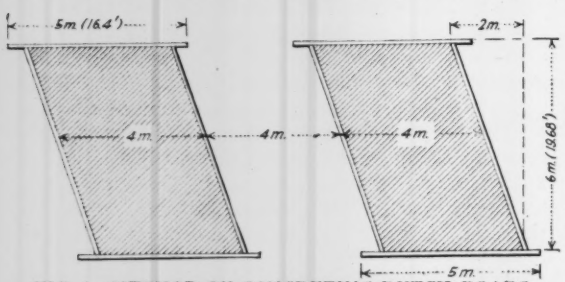


FIG. 1—METHOD OF CONCRETING DUTCH ROADS IN ALTERNATE SECTIONS

By using the alternate bay method, Fig. 1 (which consists in placing the second, fourth, sixth, etc., bays about three weeks after the first, third, fifth, etc., bays have been placed), each alternate bay is thus allowed time to take up part of its setting-contraction before the concrete of the intervening bays is placed. Consequently the width of the joint is diminished. As alternate bays with ordinary vertical joints are open to a great objection of slight displacement under heavy loads, each slab has been interlocked vertically and sideways with the adjacent slabs by means of joggled joints, Fig. 2.

The concrete was machine mixed moderately wet. Provided the mortar was not separated from the coarse aggregate in consequence of transport, the concrete was placed directly. If the engineer judged, however, that transport had to take place over such a distance that separation of the mortar from the coarse aggregate was to be feared, the concrete was mixed in the mixer with a small quantity of water and was dropped upon a wooden floor near the spot where the concrete was placed. Then water was added and the concrete mixed again, this time by hand.

The concrete for the bottom layer having been placed, it was distributed by means of a garden rake and struck off and rammed with a wood strike board, the strike board bearing upon the end boards or upon the ends of the finished slabs by means of notches 4 cm. deep, protected by running pieces. The concrete for each bay was placed immediately after the concrete for the bottom layer had been placed. When just placed the top of the concrete was 1 to 1½ cm. higher than the side and end boards. This was again tamped and struck off by a strike board.

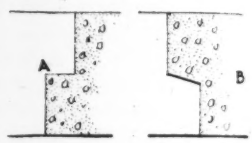


FIG. 2 — SECTIONS THROUGH TRANSVERSE JOINTS

This joint is joggled so that the sections are alternate as at *A* and as at *B*.

As soon as the concrete could be walked on, the surface was well washed and brushed first with heather brushes and afterwards with steel brushes so as to leave the gravel aggregate standing up ½ to 1 cm. clear and free. Then the surface was washed with much water. Not less than 12 and not more than 24 hours after brushing, a layer of clean sand 5 cm. thick was spread over the concrete and kept damp for two weeks. The sand was taken off in three weeks. Alternate bays were not concreted until three weeks after the first bays.

The sand having been taken off, the concrete was washed with water in such a way that a perfectly clean surface was obtained. When it was sufficiently dry, spramex was applied in one application of approximately 1.5 l. to 1 sq.m. Spramex is a semi-solid pure bitumen. It is heated in boilers to a temperature between 360 deg. F. and 380 deg. F. Then it is uniformly applied over the surface of the road by means of cans, fitted with spouts leading direct from the bottom of the cans, and immediately on application brushed so far as necessary to ensure regularity in the thickness of the coating. Immediately after the spramex is applied a uniform layer of fine gravel is spread over it in a quantity of ⅔ cu.m. for 100 sq.m. After having been rolled in by the traffic the carpet has a thickness of about 3 mm.

As a rule a short time after the construction of the road a second carpet is placed. This time only 0.9 l. of spramex to 1 sq.m. is applied. So a carpet of a thickness of 6 mm. in total is provided.

The application of the spramex must be so made as to secure a sufficient adhesion of the carpet to the concrete. The bond between the spramex and the cement mortar in the concrete is far less strong than the bond between the spramex and the gravel of the concrete. Because of this the concrete, after having been finished, was well washed and brushed so as to leave the gravel standing up free as described. It has been found in practice that it is of great importance that the layer of sand, which is spread over the finished surface of the concrete, and the water which is used to keep this sand damp, should be very clean and free from mud. Moreover, experience has shown that spramex should be applied in dry weather and upon a dry road; that in cold weather the temperature of the spramex should not be less than 380 deg. F. and that the road should not be wetted by horses or other special causes.

At first the spramex carpets were not always applied in a suitable way, and as a result a part of the carpet of the main road from Nijmegen to 's-Hertogenbosch separated from the concrete and peeled off under traffic. Consequently a part of this road was without carpet during the first winter. Before applying a new carpet the concrete

surface was examined thoroughly; the concrete was found to be perfectly sound; depressions or holes were not met with.

* * *

Denmark Installs Thin Pavements on Old Macadam

By S. Ellert
Chief Engineer, Bridges and Roads, Department of Holbaek, Denmark

THE main highways in Denmark—now under the administration of the different county authorities—were constructed by the government from 1775 to 1860 with a roadway 11 to 13 m. between ditches, a carriageway 5 to 6 m. wide of waterbound macadam 10 to 15 cm. thick on a Telford bottoming of granite 20 to 25 cm. deep. When the subsoil, consisting of clay mixed with sand, is well drained the foundation of the road is sufficiently sound to receive the concrete which it needs to withstand the strain, all the year round, of present-day traffic.

The traffic aggregates 800 to 2,500 tons in 24 hours and consists of from 20 to 30 per cent horse-drawn vehicles on iron wheels and from 80 to 70 per cent motor cars on solid or pneumatic rubber tires. The maximum load per car is 8 to 10 tons and it is not anticipated that this limit will be increased. Having regard to the relatively large number of horse-drawn vehicles and the construction of the old roads, cement concrete was used in 1923 and 1924 in the County of Holbaek, on a main road carrying a traffic load of 1,000 tons in 24 hours.

The old macadam is very carefully shaped to a crossfall of 1 in 50. It is important that the width of concrete slab should be 1 m. less than the foundation (6 to 7 m.) so that there may be a margin of 0.5 m. at each side to be covered with asphalt-concrete protecting the edge of slab. As the slab is exposed to wear and hammering of horseshoes and iron wheels it is considered best to use stone crushed to a size not larger than 10 to 20 mm. The mix is 1:2:3.

Stone and sand are deposited in measured heaps between the side forms on the clean old carriageway, so that for every 40 m. there will be just enough material for 100 sq.m. One layer of concrete is used and in the center is placed the steel reinforcement of 30 cm. Square mesh weighs 3 kg. per sq.m. Hand-tamper, roller and belt are used. A gang consists of 16 men whose daily output is 40 to 60 m. As traffic has to be maintained while work proceeds, the slab is made in 2 sections each 2.5 m. wide. A center joint is made with a key in the American way, 10-mm. steel bars across the road for every 1.5 m. The crack is closed with the painted center line dividing the traffic. No special expansion joints are used.

A reinforced slab 10 cm. thick all over seems to be sufficient on an old road of this type. It is considered possible to use a 7.5-cm. slab. It is found that the number of transverse cracks is greatly reduced compared with concrete placed direct on the subsoil. The old road crust serves as a buffer against movement in the subsoil and provides a uniform bed for the concrete. The stresses produced by movement of slab under expansion and contraction of concrete through temperature and moisture changes are decreased by the small coefficient of friction on the smooth surface of the old road.

The price has been 12 Danish crowns per sq.m. or 10 sh. per sq.yd. Of this amount 15 per cent arises in keeping traffic going, and 6 per cent for rectifying the old road. On a new road with a slab 15 to 20 cm. in minimum thickness the price will be 16 Danish crowns per sq.m. or 13 sh. per sq.yd., so the road crust represents a saving of 3 sh. per sq.yd. at least.

* * *

Swedish Engineers Follow American Practice Closely

By E. Paul Wretlind
Engineer of Bridges and Roads, Stockholm, Sweden

THE details of pavement section are indicated by Fig. 2. The width of the pavement is 5 m. The slab is laid in a single course in proportion 1:2:3½. The concrete has a thickness of 16 cm. at the center and 20 cm. at the edges. A concealed metal joint is placed in the center with 12-mm. bars spaced 1.2 m. extending across the joint. The edge reinforcement consists of a 20-mm. round smooth bar.

Construction joints have been installed at the completion of each day's work. No other transverse joints are provided. Joint filler of bituminous felt 10-15 mm. thick has been used at times when concrete was placed at low temperature. Previous experience has shown that every protection of the joint edges by means of metal reinforcement is an evil. The edges of the concrete adjacent to a joint have therefore been finished only by rounding with an edging tool having a radius of about 15 mm. The bituminous filler used in maintaining joints and cracks has a consistency corresponding to 80 penetration.

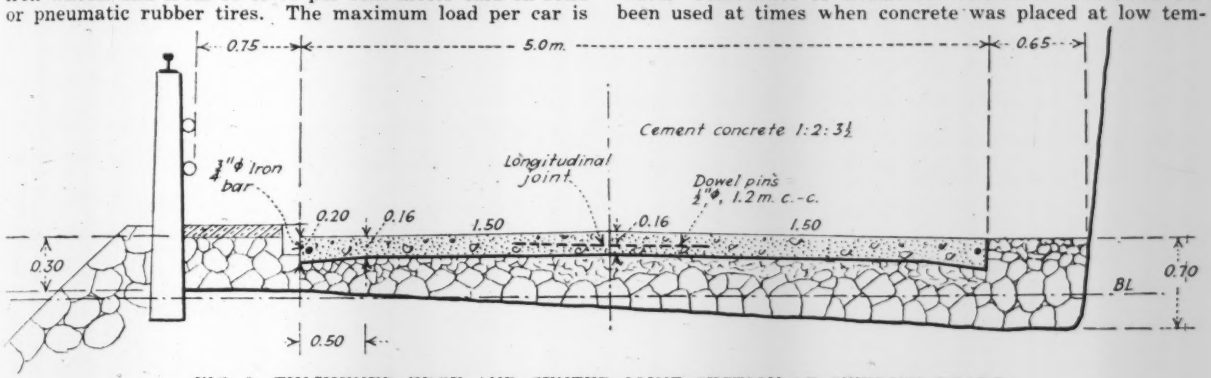


FIG. 3—THICKENED EDGE AND CENTER JOINT SECTION OF SWEDISH ROADS

The method of curing has been to cover the pavement with about 50 mm. loose earth which was kept moist by frequent sprinkling for 8 to 10 days. The earth covering remained on the concrete for at least two weeks. On road shown in Fig. 3 a solution of waterglass (spec. gravity 1.06) was sprinkled on the surface as soon as the concrete had taken its initial set. The object was to hasten the setting and thereby lessen the chance of the surface getting hurt.

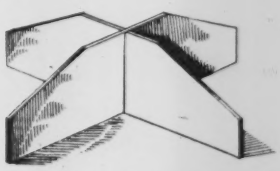


FIG. 4—LEAD DEVICE SET IN CONCRETE TO MEASURE WEAR

The cross-section of the slab has been modified according to modern American concrete slab design. While strengthening the edges which are considered the weakest parts of the pavement the average thickness of the slab at large was lessened at considerable saving in cost of construction.

An interesting device for measuring the wear of a concrete road surface was invented by S. Ekelund at the Swedish Institute of Roads. The device was installed on roads 18 and 20. The device (Fig. 4) consists of two narrow lead plates fixed together at right angles. The top corners of the plates are cut so as to form slopes 1 on 2. At the top the crossarms have a total length of 100 mm. each. In installing the device in the concrete great care must be exercised to get the edges in exact level with the pavement surface.

Italy Builds Special Motor Roads

By Franklin Colamonico
Civil Engineer, Ministry of Public Works, Rome, Italy

NOTABLE concrete road undertakings in Italy are the completed motor road from Milan to the Lakes, 85 km., and the projected motor roads from Milan to Bergamo, 49 km., and from Naples to Vietri sul Mare, 45 km.

For a traffic of four rows of motor vehicles the width of 10 m., besides the footpaths of 1.50 to 2 m., has been used for the two first sections of the Milan-Lakes road for 33.1 km. For reasons of economy it has been decided to reduce the width of the other three sections of the Milan-Lakes road, 51.92 km., to 8 m. besides the two footpaths of 1.50 m. The second section of the Milan-Bergamo road, 37.828 km., and the Milan-Turin and Naples-Salerno motor roads will also be 8 m. wide.

This width of 8 m., besides footpaths of 1 to 1.50 m. each, has been considered amply sufficient for a traffic of two lanes, one for each direction, with a possibility for faster vehicles to pass by at least in one direction. Some experts consider that a width of 7 m. is sufficient for this purpose, considering the lesser widths of touring cars, but it must be borne in mind on the other hand that in view of the high cost of this work it is better to construct wider roads from the very first, thus providing for the requirements of motor car, large motor bus, etc., instead of having to extend the widths of the roads gradually, thus reducing the width of the footpaths, as has become necessary elsewhere.

The section for these roads for the straight lines and large radius bends has a slight curve with a crossfall not over 1/100 in a transverse direction. The thickness of the road was kept at an average at 20 cm., it being reduced to 18 cm. in the middle and raised to 22 cm. at the sides.

The well-known American mechanical processes were used for mixing, laying and finishing the cement concrete on the motor roads. The cement concrete was allowed to mature under layers of earth and straw kept moist by means of regular watering. As a rule roads are opened for traffic only after 28 days of curing, and it is advisable to extend that period as much as possible. Experience shows that the resistance to compression of cement concrete increases 40 to 50 per cent and even more between 28 days and three months old. Traffic should not interfere with this phenomenon of gradual consolidation. Coating with Mexican bitumen was resorted to for protecting the cement concrete, but a first application of tar by the hot process seems to be advisable, as the tar adheres better to the cement concrete and prepares for the better adhesion of the subsequent applications of bitumen.

* * *

Concrete Surfacing in Experimental Stage in France

By R. Feret
Chief, Laboratory of Bridges and Roads,
Boulogne-sur-Mer, France

IN FRANCE the most frequented routes upon which special surfaces are particularly appropriate already exist as metaled roads, whose surfaces although worn afford a solid foundation for the new crust. It is only necessary, as a rule, to lower the crown in places so as to produce a gentler camber (to about 1:80), better suited to new surfacing methods. Where the old foundation has to be destroyed as well as in the case of entirely new roads, the necessary precautions are taken to ensure an impermeable and firm foundation. Where the old road can be utilized, some engineers score the surface so as to secure better adhesion with the upper layer, while others leave it intact. There are conflicting theories whether the adhesion of the surface to its subgrade facilitates or prevents the formation of fissures by contraction.

On account of the firm support given by the old metaling most French contractors use a single layer of concrete which has the advantage of simplifying construction methods. Others prefer, however, especially when the foundation is not uniform, to use two layers, the lower being composed of a poor concrete in which local materials, even if of indifferent quality, are used, while the upper is rich in cement and made with a selected aggregate. Care must then be taken that the first layer has not begun to set when it is covered by the second.

When it is applied as a single layer the concrete is generally made of about a cubic meter of hard broken stones (in fixed proportions of stones and of shingle or screenings) 500 liters of sand and from 350 to 450 kg. of cement. In surfaces formed in two layers, the upper one is richer and some contractors go so far as to make it with 700 to 800 kg. cement to the cubic meter of stone without any addition of sand.

Most often either ordinary portland is used or portland improved, to develop quick setting properties (super-portland)—sometimes also high alumina cement. Certain patentees advise the addition to the cement of more or less secret compounds which in their opinion would give the concrete special qualities of hardness or elasticity. But general experience goes to show that the good results often obtained should be attributed much less to these special additions than to the proportions adopted for the concrete and to the processes employed in its application—precautions which would assure the same result with ordinary cement employed under the same conditions. Conveyed in skips the concrete is generally spread with a shovel on the bed previously prepared and watered, then levelled to a thickness 10 or 15 cm. greater than the dimension desired after complete consolidation.

Hand-ramming is too lengthy, laborious and unreliable to be applied on large contracts. For compression by rolling the concrete must be dry enough not to squeeze out under the roller and make a wave in front, thus tending to destroy at each reverse the effects of the previous compression; for the same reason the use of too heavy a roller should be avoided. This necessary dryness of the concrete may have the serious inconvenience of causing a too rapid set beginning before the rolling is finished. Moreover in order to compensate for the want of cohesion which results and to hinder the picking up of the concrete by the roller one is apt toward the end of the operation to water the surface under treatment more or less abundantly with the risk of carrying away part of the cement in a milky state and of subjecting the concrete, if it has begun to set, to the harmful effects of disturbance. Evenness of camber is obtained by eye-judgment and is corrected when necessary by additions of concrete, in the course of the rolling, at the points where the need appears. Indeed compression by rolling appears to be a delicate operation since it demands special care and well trained workmen. Some contractors lessen these drawbacks either by spreading the concrete in several layers, rolling each in succession or by giving the first consolidation by other processes and only employing the roller to complete the operation.

Another method of compression which is more and more used depends on the use of pneumatic tampers whose vibratory action produces a high degree of consolidation. It has the advantage of working best on a moderately wet concrete avoiding the too rapid set of a dry concrete as well as the excessive weakness of an unduly wet concrete. But the regularity of camber is rather difficult to achieve in the first instance and should be ensured by other means. One French undertaking employs the American finishing machine (Lakewood) for applying concrete to the roads. This costly apparatus suitable above all for very important contracts and when it is possible to work on the whole width of the road at once does good work, but in our opinion, has the disadvantage of requiring a too wet mixture, losing on this account, especially in the upper layer where the water has always a tendency to rise during the tamping a good part of the strength which it would obtain with less water.

One practical device for compression similar to the preceding although less rapid but having the advantage of requiring only very simple plant and of being applied on the smallest jobs consists of tamping the concrete by means of a weighted templet with the desired cross section; it is worked by hand by two men standing on movable gangways one on each side of the road; the templet takes its bearing at each end upon carefully regulated longitudinal guides which are removed when the work is finished. Sometimes two templets are employed following each other at short intervals—the first for the tamping proper, the second for the completion of the smoothing process. Hand-floating completes the work of the tampers in giving the ultimate finish to the surface. Whatever may have been the method

of consolidation this finish may be obtained by several other processes; sweeping, smoothing with the trowel, small hand-rollers, polishing bands, straight edges applied longitudinally, etc. Some contractors deem these methods superfluous and depend entirely on the eye and the skill of the workmen.

Sometimes the new concrete is protected by tarpaulins from the weakening effect of heavy rain, and also during the first days after being laid, the surface is preserved from too rapid drying by straw, sand which is watered; other similar precautions could be cited. One of the questions still most often discussed is that of expansion or contraction joints. As their usefulness has not yet been clearly shown most French contractors are contented to leave a joint wherever work is resumed after the necessary daily cessation; some contractors dispense with joints altogether. There are a great many kinds of joints formed for the most part of elastic substances. Often the new concrete is merely applied against the clean surface of the old without intermediary material. At times, in order to insure a better union the new concrete is made richer near the joint. The plan of preventing contraction by constructing the surfacing in alternate bays has also been tried—the concrete being applied to every other bay, the intervening spaces being filled in after the first have had several days to harden.

Whatever system is adopted and whatever precautions taken, it is seldom that a transverse crack does not quickly appear along the joint and later at intermediate points, even when joints have been provided. At first the cracks (capillary in character) cause no inconvenience except by giving an impression of faulty work; but in the course of time the edges break away; the opening increases and may become the cause of more serious disintegration. Without waiting for this stage the edges should be cleaned and the fissure filled in with quick-setting mortar (for instance with an aluminous cement) or with some more or less fluid bituminous dressing, after which the highway, striped with black bands like a zebra, suggests the inartistic appearance of an old coat, seamed and patched, although its suitability for traffic is fully preserved. The chief problem that remains to be solved in the construction of concrete roads is to avoid the forming of these fissures as well as of those often to be found along the crown where the joint occurs, when the surfacing is done in half widths.

One way of concealing these repairs as well as protecting the surface of the concrete is to tar it. It remains to be seen whether the advantages of so doing would compensate for the corresponding expense; besides some engineers consider that tarring makes the concrete very slippery. In any case the first application ought not to be made until the road has borne enough traffic to loosen the superficial film which is the result of the drying of the laitance which rises to the surface.

* * *

Patented Concretes Used in Belgian Pavements

By E. Piens and G. Luyssen
Engineers of Bridges and Roads, Brussels, Belgium

Belgium has extensively used patented and special concretes for surfacing macadam on telford. The interests controlling the materials generally also put them in, as they have developed systems of construction and special equipment and working procedure.

Rhoubenite concrete, controlled by Hanesse & Rochette of Brussels, is composed as follows:

Broken porphyry stones 20/40 or 40/60 mm	0,500 cu.m.
Small broken porphyry stones 5/20	0,500 cu.m.
Rhine sand	0,300 cu.m.
Artificial Portland cement	350 kg.
"Houben" powder	16,800 kg.

This system of surfacing seems capable of bearing traffic wear even beyond present-day proportions, on account of the cohesive powers and the interior stability of its constituent elements. It appears pre-eminently suitable for suburbs of large cities, where the roads do not cover over water, gas and electricity mains.

Soliditit concrete is composed exclusively of Soliditit cements coming from the cement works of the Société Anonyme des Ciments de Mons, and porphyry material, excluding sand. The mixture used contains 700 kg. of Soliditit cement per cu.m. of small broken porphyry stones, called Belgian ballast, of 10/50 mm. gage.

A section of soliditit pavement on the road from Brussels to Nemour is shown by Fig. 5. As the first use in Belgium dates only from 1922, judgment on the merits of this process must wait until time and experience will have given the necessary knowledge. However, these surfacings already appear to be an improvement over those made of ordinary cement.

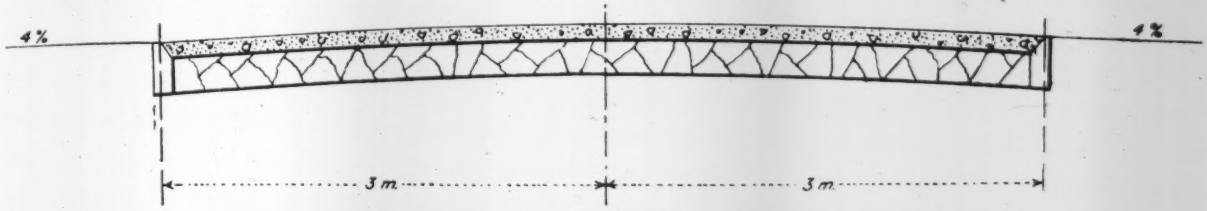


FIG. 5—PAVEMENT OF SOLIDITIT CONCRETE USED IN BELGIUM

Use has also been made, in a measure experimentally, of gunite and of weak mortar (slug cement and granulated slag) concretes. The general conclusions drawn from experience with all these patented roads are:

1. The systems of surfacing in special concrete made with rich mortar, such as "Rhoubenite" and "Soliditit," necessitate, in spite of the incorporation of the special "Houben" powder on the one hand, and in spite of the special "Soliditit" cement on the other hand, the use of expansion joints in the road. These expansion joints seem indispensable for all other surfacings made of rich or weak mortar.

2. The expansion joints made with clay wash, coatings of bitumen, metal plates of extra soft steel, or thin laths of hard creosoted wood appear to have given good results.

3. In order to lessen the influence of these expansion joints, it seems advisable to construct the concrete surfacing in odd and even sections, so as to reduce to a certain extent the contraction due to the crystallization of the concrete.

4. The repairs which it is necessary to make in concrete surfacings are at present comparatively easy to carry out, owing to the use of plant worked by compressed air.

5. It is advisable to impart to the concrete the desired compactness and cohesion and thus increase its resistance by the use of pneumatic tamping.

6. It is desirable to reduce to the strict minimum the camber of the surfacing. A rise varying from $\frac{1}{80}$ to $\frac{1}{100}$ of the width of the surfacing, according to circumstances, seems to be sufficient.

7. The study of concrete surfacings made with weak mortar should be continued, especially in countries posessing iron foundries and producing blast furnace slag and slag cement. These surfacings are specially suitable for roads having a medium and semi-heavy traffic.

8. It is desirable to continue the study of coatings: mineral tar, de-hydrated tar, spramex, cold-spray, spray-emulsion, tar-emulsion, bitumix, tarmix, etc., used with concrete surfacings. They protect these efficaciously, especially when they are cracked and fissured, and increase their coefficient of adherence, while rendering them absolutely waterproof.

9. In spite of what the promoters of certain systems of special surfacings claim, it seems indispensable to allow the concrete to set as much as possible before handing it over to traffic again. In the case of concretes made on a basis of Belgian cement, it appears to us that the interval should be at least 21 days for artificial Portland cement, and a little less for slag cements.

Electric Coal-Car Dumper Handles 120-Ton Carloads

Powerful Machine for Cars of 120 Tons Load Capacity—Automatic Control of Mule Hoist, Clamps and Cradle Movements—Coal Yard Layout and Operation—Dock Wall Foundations

FOR EFFICIENT operation of its increasing coal shipping business at Toledo, Ohio, the New York Central R.R. has this season replaced its old steam-power car-dumping machine at that port with an electrically-operated car dumper which has a novel system of electrical control and is designed to handle large cars of 120 tons load capacity, representing a total weight of 165 tons on the cradle of the dumper. In Fig. 1 a loaded car has been raised and is being overturned in the cradle, discharging the coal into the triangular pan or apron, from which it flows through a telescopic chute adjusted to the hatch of the steamer.

Coal Traffic at Toledo—Of nearly 14,500,000 tons of coal loaded into vessels at Toledo in 1925, the New York Central R.R. handled 2,643,302 tons with its old dumper designed for 50-ton cars; the Baltimore & Ohio R.R. handled 3,316,540 tons with a dumper for 100-ton cars, and the Hocking Valley R.R. handled 8,473,434 tons with two dumpers, each designed for 100-ton cars. Coal from the Ohio, West Virginia, Tennessee and Kentucky coal fields is brought to Toledo by trains of the Ohio Central and Big Four lines of the New York Central R.R. System. Rapid loading is required in order to ship as much coal as possible during the season of navigation for storage as winter supply at ports on the upper lakes. A considerable proportion of this traffic is handled by the large steamers which bring iron ore from the upper ports for the steel plants of Ohio and Pennsylvania. In addition, there is shipment by steamers and barges to various points on the lower lakes.

Coal Yards—Inbound coal trains of the New York Central lines are delivered at a receiving or supporting yard about three miles from Toledo, but the present facilities will be improved with the completion of a new classification yard about a mile further out and now under construction. From either of these yards, trains or cuts of about sixty cars will be hauled by switching engines to a four-track storage yard of 160 cars capacity near the south end of the coal shipping dock.

A plan of the tracks serving the car dumper is given in Fig. 2, with a profile in Fig. 3. Behind the car dumper there will be noted a group of four stub tracks alongside a slip. These tracks are used occasionally for storage of coal cars waiting to be sent to the dumper, but their main purpose is for unloading ore from vessels moored in the slip. Three gantry cranes spanning the tracks are equipped with grab buckets for unloading the ore and placing it in cars or in a storage pile for future loading. The loaded ore cars are then taken to the outer classification yard to be made up into

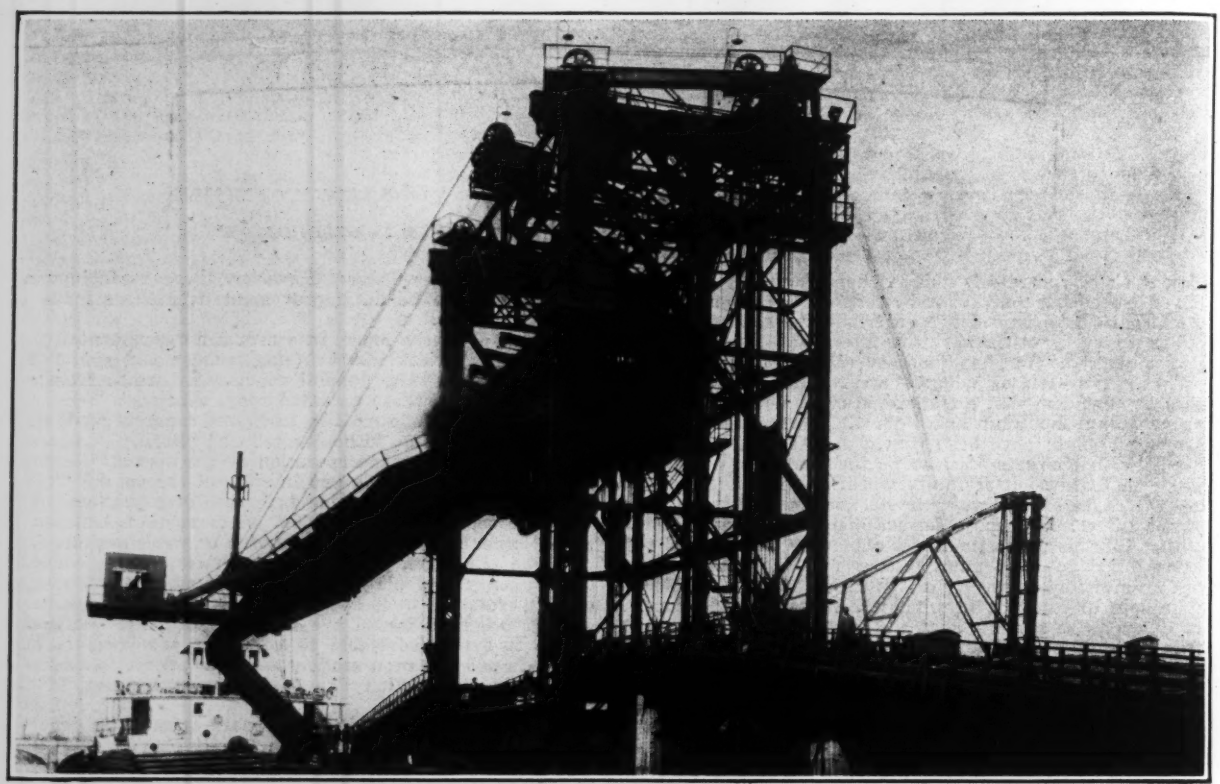


FIG. 1—COAL-CAR DUMPER FOR 120-TON CARS AT TOLEDO: NEW YORK CENTRAL R.R.
Cradle raised and rotated, dumping coal from car into inclined pan with adjustable chute lowered to ship's hatch. Main operating cab on tower. Chute controlled from cab at end of pan.

outbound trains, the cars being weighed on a track scale on their way to the yard. The yard tracks are laid mainly with 80- and 90-lb. rails, 16½-ft. switch rails and No. 8 frogs on the ladder tracks. Flood lights on the tower of the car dumper provide for lighting the dumper and adjacent tracks.

Handling the Coal Cars—From the storage tracks the cuts of cars are pushed to the summit or "high buck" of a grade of 2.8 per cent. There they are uncoupled in turn and each car, under control of a brakeman or car rider, runs alone down a grade of 1.4 and 0.8 per cent, being then stopped by the hand brakes at the bottom of this grade, where the track passes over the pit of the barney car or "mule." This mule, which travels on a narrow-gage track laid between the rails of the coal-car track, is attached to the cable of an electrically operated hoist and has a push bar to engage the rear coupler of the coal car.

next loaded car and runs down a 7 per cent grade to a "kick-back" having a 25 per cent grade and an automatic spring switch. This kick-back reverses the movement of the car and the switch diverts it to the return track on which it runs down a grade of 2 per cent to the yard for empty cars, where the tracks are level. The switching engines take cuts of empty cars back to the supporting or classification yard to be made up into outbound trains for return to the coal fields. This track arrangement and plant is designed to handle forty 120-ton cars per hour, as against twenty 50-ton cars with the old machine.

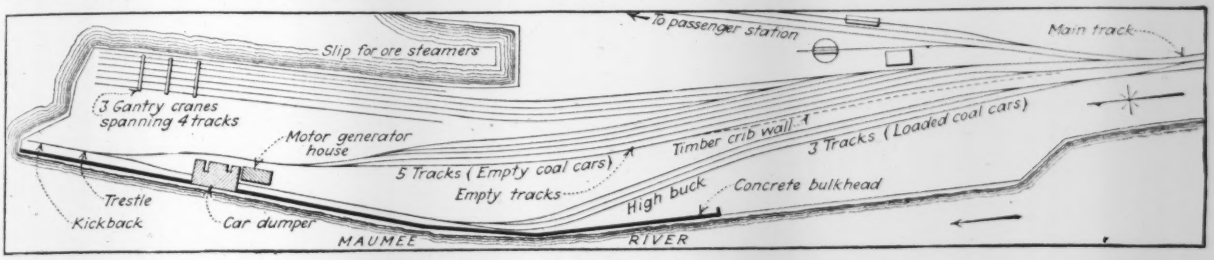


FIG. 2—LAYOUT OF COAL YARD AND CAR DUMPER AT TOLEDO

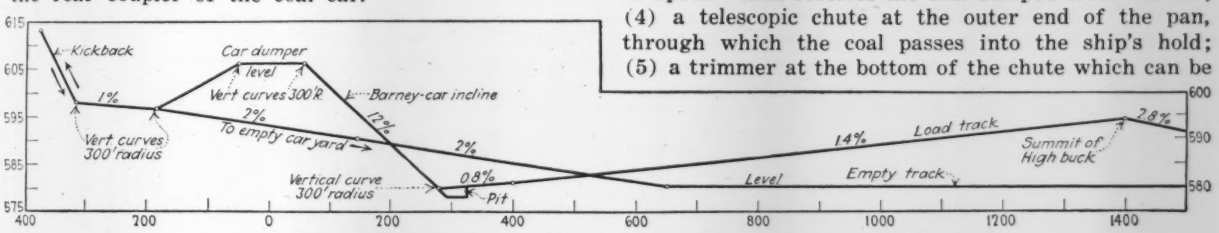


FIG. 3—PROFILE OF TRACKS TO AND FROM CAR DUMPER

Car Dumping Machine—In general, this car dumper consists of the following parts: (1) A steel tower 36x70 ft. and 108 ft. high, giving a dumping clearance of 64 ft. between the front columns; (2) a lifting cradle operated in the tower; (3) an adjustable pan or apron which receives the coal dumped from the car; (4) a telescopic chute at the outer end of the pan, through which the coal passes into the ship's hold; (5) a trimmer at the bottom of the chute which can be rotated around the axis of the latter so as to control the direction of discharge of the coal; (6) the machinery equipment, housed under the tower; (7) the electrical sub-station equipment.

When the operator at the dumper shifts the controller of the hoist, the mule moves up behind the car and pushes it up an incline with a grade of 12 per cent to the cradle of the dumper, the full-speed movement being about 900 ft. per minute. If the cradle is not seated, the car is stopped automatically about 50 ft. from the top of the incline. On the approach to this incline is a bypass gate to a depressed narrow-gage track by which the returning mule may pass under a coal car standing over the pit. When the mule is started forward to push the car up the incline, it passes over another bypass gate at the rear end of the pit and then rises behind the car until its track is at the same elevation as that of the coal car.

As the loaded car enters the cradle it is stopped in proper position by the brakeman and while he is getting off the car the main operator on the dumper shifts the haulage controller to return the mule to its pit. When the brakeman is clear of the cradle, the operator throws the cradle controller to the hoisting position. As the cradle starts to rise, the car moves sideways against the stops and is clamped automatically to hold it in position when it is turned over by the cradle to discharge its contents.

When the cradle has been lowered and returned to its normal position, the empty car is pushed off by the

The tower is located on the concrete dock, with its cradle track 25 ft. above the dock and with its pan overhanging the water. This pan, 43 ft. long, is 64 ft. wide at its upper end, sufficient to receive the coal from the largest railroad cars, and then narrows to 5 ft. at its discharge end, where the telescopic chute is attached. Two movements are provided for the pan; its upper end is carried by a girder which can be raised and lowered within a vertical range of 24 ft., while its outer end is attached to cables which pass over sheaves on top of the tower and are led to the drum of the pan hoist. The chute is composed of four telescoping sections, giving an adjustable length of 13 to 28 ft., and is so hinged to the pan that it can be swung in a vertical plane at right angles to the dock line.

A special feature in the design is that the pan girder travels on the front faces of the front columns, with its operating screws carried on brackets on the faces of the columns, where they are free from danger of interference with the coal cars. Another feature is that the cradle is over-counterbalanced, so that the power required to raise the cradle and loaded car is practically

the same as that required to pull down the cradle and empty car, thus reducing peak loads. From each of the two drums of the cradle hoist, cables lead to both ends of the cradle, and either drum is capable of holding the cradle in case of failure of a drum shaft or gear.

Clamps to hold the car in position while dumping consist of cast-steel beams on hook castings which travel in guides on the back of the cradle, where they do not interfere with the flow of coal and are more readily kept clean than if placed on the dumping side. Counterweights attached to pivoted arms hold the clamps clear when the cradle is seated. As the cradle is raised, the clamps descend to the top of the car, and when the cradle has rotated about 50 deg. they connect automatically with the clamping cables which hold the car while dumping. These cables are released again when the cradle returns to the 50-deg. point. Finally, as the cradle reaches its seat, the counterweights are deflected by inclined guides and thus raise the clamps from the car.

Machinery Equipment—The cradle hoist and mule haulage machinery are housed beneath the cradle, which stands 25 ft. above the dock, but the pan hoist machinery is in a separate house at the back of the machine, while the motor for operating the pan-girder screws is on an open platform at the front of the machine. Two drums for the cable hoist, with their axes at right angles to the dock line, are geared to a single pinion on an intermediate shaft, which in turn is driven from the motor through a double-helical gear. A hand-operated emergency brake is provided on the pinion shaft, and each motor has a service brake which sets automatically when current is shut off. Counterweight ropes attached to these drums unwind as the cradle is hoisted, the counterweights thus assisting the motors in revolving the drums. Operating records of this plant are said to show a power consumption of approximately 0.27 kw.-hr. per ton of coal hoisted.

All motors are for 250-volt direct current and are rated as follows: Two 450-hp. motors for the cradle hoist; two 450-hp. for the mule haulage; one 295-hp. for the pan hoist; one 105-hp. for the pan-girder screws; two 45-hp. for the telescopic chute; one 13-hp. for the mule-track gates. The cradle hoist motors are driven by separate direct-current generators mounted in the substation and controlled by adjustment of the generator fields by magnetic controllers operated from the cab by a small master switch. For the mule-haulage rope, the drum has a herringbone gear with two driving pinions, each connected to a motor by a flexible coupling. Manually-operated emergency brakes are provided outside of the flexible couplings, and each motor has an electrically-operated service brake. The motors are driven by separate direct-current generators in the same manner as the cradle-hoist motors.

For the pan hoist, the mechanism consists of a drum geared to a motor provided with rheostatic control operated by a master switch in each of the two cabs. Either of these switches may be used to operate this mechanism, but only one at a time. This mechanism includes an electrically-operated service brake on the motor and a solenoid emergency brake operated from either cab, the latter being so arranged that this brake must release before the service brake releases, either in raising or lowering the pan.

With the electric control system and the introduction of automatic features only two operators are required; one is in an elevated cabin on one of the front columns of the tower, to control the cradle hoist and barney car; the other is in a cab located on the outer end of the pan to control the movement of the chute, screw girder and pan. The screw girder and pan can also be controlled by the main operator, but the

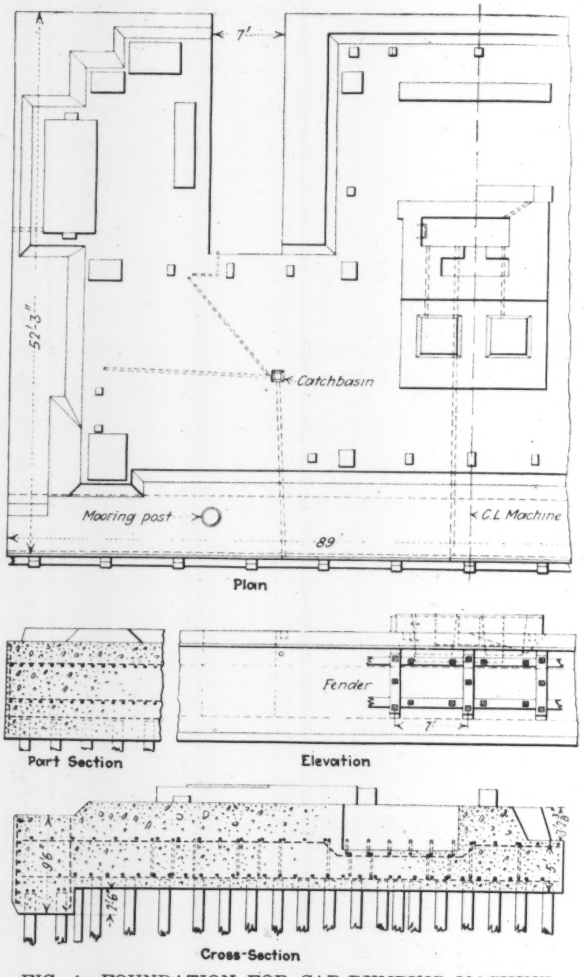


FIG. 4—FOUNDATION FOR CAR-DUMPING MACHINE

controls are electrically interlocked so that they can be operated by only one man at a time.

Electrical and Automatic Control—In the electrical equipment, a special feature is that this is the first car-dumper having generator-field control (Ward-Leonard system) for the operation of the mule haulage and cradle hoist functions. The auxiliary functions are operated by rheostatic control. All operations are effected by 250-volt direct current.

On the mule haulage, automatic limit switches provide acceleration of the mule or barney car out of the pit, slow-down to engage the loaded coal car, acceleration after engagement, and slow-down and final stop at the top of the incline. An interlock on the cradle operates to stop the mule near the top of the incline if the cradle is not in position to receive the coal car. On the return trip, automatic switches accelerate the mule on the incline, slow it to enter the upper bypass gate, accelerate it again, and then slow it and stop it in the lower pit. The mechanism for operating the bypass gates is located at the upper gate and is so interlocked

with the mule haulage mechanism that the upper and lower gates are always in the proper position. All of the above operations are automatic, but the operator can control them manually with a separate switch if necessary.

In hoisting, the cradle is held vertical by cross heads which travel in guides in the main columns and by rollers engaging the columns near the bottom of the cradle. Hooks on the adjustable pan girder engage pivot pins on the cradle at the completion of the vertical lift, thus causing the cradle to rotate about the cross head, the rollers then leaving contact with the columns. A limit switch of the traveling-nut type controls the automatic features, which include acceleration and slow-down to engage the hooks; accelerating on turn over and then slow-down and stop to dump; acceleration in the reverse direction; slow-down to disengage hooks; lowering acceleration, slow-down and final stop. In

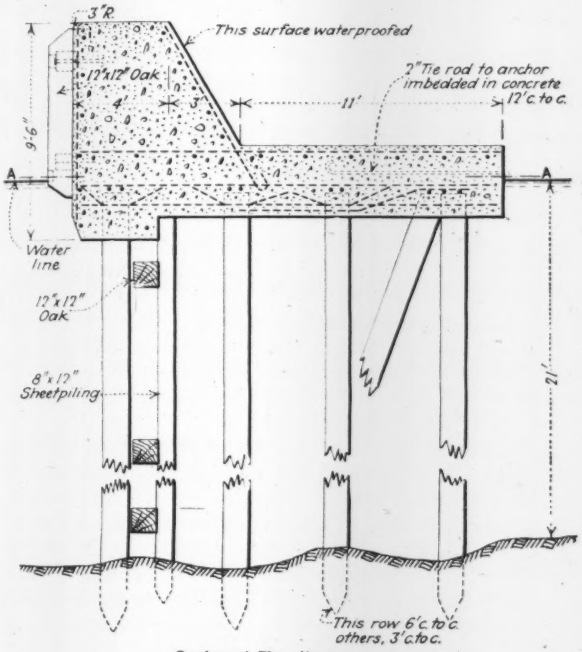


FIG. 5—CONCRETE BULKHEAD OR DOCK WALL

dumping, the operator can stop and hold the cradle at any desired position.

As the slow-down and final stop in seating the cradle always occur at the same place, the limits are placed in a fixed position on the structure. The automatic functions around the pivot pin, however, are required to operate with the pan girder in any position. This variation is adjusted automatically by a differential-gear device geared to the cradle hoist and pan-girder screw mechanism. As this girder is moved it advances or retracts the traveling nuts in the limit switch, so that they will function properly when the cradle is hoisted into the hooks.

Features considered as of special note on this installation are: (1) Flexibility of operation; (2) use of one main operator instead of two employed on the old steam dumper; (3) much lower stand-by losses; (4) saving of about 30 per cent of current consumed with the generator-field control, as compared with rheostatic control of mule and cradle; (5) readiness to operate; (6) ability to handle heavy cars without loss in speed; (7) smooth uniform rotating torque and cushioning effects of generator fields, giving longer life to ropes, machinery and structure.

Foundations and Dock Wall—The foundation for the car-dumper, shown in Fig. 4, consists of a reinforced-concrete mat or platform approximately 90x52 ft., with a thickness of 8 ft. 3 in., increased to 9 ft. 6 in. at the water front. This mat is built on piles, with a line of wood sheetpiling behind the dock wall. Upon the upper surface are formed low pedestal footings for the steel columns of the superstructure. In line with the face of this foundation mat is a concrete bulkhead or dock wall against which the coal vessels are moored and which retains the fill of the yard tracks. It is built mainly on the harbor line of the Maumee River, as laid down by the United States Engineers. There is a depth of 23 ft. of water along the bulkhead and dumper.

This concrete bulkhead, Fig. 5, is of L-section, the higher portion forming the dock wall, 9½ ft. high, the back of which is covered with a waterproofing composition. The 36-in. base extends a total width of 15 ft., supporting the fill behind the wall. Anchor rods 12 ft. apart and having looped ends are embedded in the concrete base and extend back to deadmen or anchor piles in the fill for the new yard. The bulkhead is supported by four rows of piles, those of the rear row being braced by batter piles, all with an average penetration of 18 ft. Behind the first row of piles is a line of 8x12-in. splined sheetpiling to hold the fill. This sheeting has a penetration of about 6 ft. and is stiffened by three lines of 12x12-in. oak waling timbers.

Engineers and Builders—This high-capacity, electrically operated and automatically controlled car dumping machine, with its machinery equipment, was designed and built by the Wellman-Seaver-Morgan Co., this work being in charge of A. F. Case, manager of that company's ore and coal division. It was erected on foundations which, with the concrete dock wall, were provided by the railway. All electrical equipment was supplied by the General Electric Co.

The design and construction of the car-dumper, dock wall and new coal yard facilities were under the direction of J. A. Stocker, chief engineer of the New York Central R.R. (Ohio Central Lines), with Karl A. Borntrager as resident engineer in charge of construction. The electrical installation was under the supervision of J. P. Puette and C. S. Albright, supervisor and assistant supervisor of electrical appliances, New York Central R.R. (lines west of Buffalo). Work on the foundations and the bulkhead was started in April, 1925, and erection of the car dumper began in October. The first coal was dumped on March 21, 1926, and the entire plant was completed and in regular service in June, before the heavy northbound shipments of coal began.

The Civil Engineer in Industry

AN EDITORIAL SURVEY

II. Executive Engineering

The Second of Four Articles Reporting the Results of a Study Into a Little Appreciated Field of Civil Engineering

INDUSTRIES the country over are more and more becoming convinced that technically trained men are of extreme importance in their business. The work these engineers do need not be restricted at all to technical service. But the training and oftentimes the technical experience which a man takes into an industry carries so high a dollar and cents value that a few years may find him high in executive authority.

If one seeks general proof of the increasing use of engineers in executive positions, he has but to follow the development of America's large business establishments of 50 years or more. Latterly there is unmistakable evidence of the popularization of the engineer to be found in the lengthy list of laborers and small merchants who have cribbed his name to piece out their own deficiencies. To these the word engineer stands for precision and unquestioned ability. The small shopkeeper believes that the lay mind is much more impressed by "wallpaper engineer," than by the simple statement "wallpapering done." An exterminating engineer is believed to be a person who actually can rid a house of vermin. Flippant as it may appear to take note of the endless scores of such so-called engineers in a serious discussion, it nevertheless tends to show that the engineer is a great deal more appreciated technician than he was a decade ago.

Data on Technical Graduates

As an indication that the engineer has a distinct place in executive positions in industrial plants, some figures recently given out by two of the principal engineering schools are illuminating. Out of 1,736 graduates of The Massachusetts Institute of Technology between the years 1868 and 1924 inclusive, 7.7 per cent were in manufacturing or industrial positions. This percentage was of men in executive or administrative and not technical positions in the companies which they served. While it is not possible to discover what a large majority of these men are now doing, since they do not maintain their original technical contacts, because a good many of them still continue to consider civil engineering a first love, *Engineering News-Record* has been able to get interesting data on their operations.

From Rensselaer Polytechnic Institute which was established in 1824, and which gave its first degree in 1826, the list of graduates with their current occupations, or positions held at the time of their decease, given in the catalog of 1926, shows that 195 have become presidents of corporations of various kinds, 148 have become vice-presidents, secretaries and treasurers, 246 managers and superintendents, and 111 chief engineers: a total of 700 holding high executive positions; also 42 are classified as sales engineers. Consulting engineers number 100. The number of architects and members of engineering and contracting firms, not counted above, is 77. Officers of the U. S. Army and U. S. Navy number 96 including two brigadier-generals and three rear-admirals. In institutions of learning the professors total 91 and the instructors 86. Physicians, lawyers and clergymen number 92. Other graduates, including some of the younger ones, hold other positions of great importance in many branches of engineering and business. Alumni, including those referred to above, have held important executive positions on more than 200,000 miles of the railroad systems of the United States as well as on many miles of foreign countries.

The total number of graduates, living and dead, at the time of issue of the catalog of 1926, was 3,351. Of these, 1,150 were graduated in the last ten years and most of these have not had time to attain executive positions, though more than 100 of these have done so.

Civil Engineer in National Lead Co.

One of the outstanding cases wherein the civil engineer is fully appreciated as an executive as well as a designer or a constructor is found in the National Lead Co., St. Louis. The engineering function of that organization has spread along three lines: Development, construction and operation. These divisions are considered natural results of the questions which arise with the management: Are we doing this thing the best way? Can we do this? What can we do?

The management selects engineers to answer these questions, "for two reasons; first, the engineer has been trained in the use of the intellectual and physical instruments useful in finding answers to the questions; and second, the engineer has been trained in independence." These quotations are from the management.

The first purpose of the engineering department, according to E. C. Walker, is development, mostly of manufacturing methods and processes. Construction necessarily follows and operation is assumed by the engineering department while a method is new and also in emergencies.

To tell the complete story of the engineer's function in the National Lead Co., let Mr. Walker speak:

"An industry depending upon one of the arts has problems which arise in most of the other arts. A man having experience in one industry may be able to cope with most of the difficulties which arise in that industry, but very likely is unable to translate principles of one art into the principles of even kindred arts. The engineer is particularly trained in this kind of translation, and this accomplishment much more than compensates for his lack of experience along the line in question, because he is able to give to the industry the best that has been found by all the other industries.

"The engineering department does a special kind of accounting, somewhat resembling cost accounting, but the purpose of this is to answer the question, Are we doing this thing the best way? or to check a change in method or of personnel. Figures made by this class of accountants never directly reach the general ledger.

"A chemical laboratory is a necessary adjunct to an engineering department which seeks to perform completely the engineering function. Our laboratory is in charge of a chemist equipped not only for control work and checking materials, but to make the chemical investigations needed in connection with the diversified problems coming to the department. There is no such thing as a classification of the questions which are put to the engineering department of an enterprising industry. On the same day in this department we were called upon to find the reasons for certain defects in baby ribbon and operating methods which would lessen the depreciation of locomotive boiler tubes.

"Obviously we cannot afford to keep on the payroll a man experienced in each of the lines along which questions will be asked. The more economical way is to provide a few engineers whose training in the science of physics and in manufacturing practice will enable them intelligently to investigate conditions and make use of all the experience available on the part of men in touch with the situation, then get the answer."

A Manufacturing Executive

Coming to an entirely different field, we find the director in charge of engineering of one of the largest corporations in the United States in the needle industry, a civil engineer, with a great pride in his original profession, a non-technical executive in an organization which turns out the largest product of its kind in the country.

After having been graduated from Rensselaer Polytechnic Institute this executive entered the army and shortly became a first lieutenant and later a captain in the 1st Regiment, U. S. Volunteers. He had charge of hydrographic and topographic surveying as engineer officer of the 3d Battalion stationed at Guanica, Porto Rico. After the close of hostilities, he stayed in the War Department designing locks and movable dams for the government until 1901 when he was made mechanical engineer of the Walter A. Wood Mowing & Reaping Machine Co. He worked through various stages of the manufacturing plant, including grey iron foundry practice, malleable iron foundry practice, brass foundry practice and shop work on all the various parts that constitute reaping machinery. He left there in 1919, having been vice-president and general superintendent of the Wood company for several years previously.

In his present position, as director of this large corporation, his responsibilities far exceed those of the engineering department of which he is the head. His judgment is sought in matters of general manufacturing methods, development of labor-saving machinery and even supervision of personnel.

The substance of this executive's whole attitude toward the adaptability of scientific training in manufacturing is as follows:

"I believe that an engineering training is very valuable in any branch of business life. I find here in our needle industry every part of my experience has become useful, even the foundry practice. While I have charge of the engineering departments for our many factories situated in different cities in the United States and Canada which naturally includes the customary supervision or direction of construction of buildings, power plants and other features, yet the greater portion of my time is consumed in problems relative to manufacturing.

"Without going into details it must be perfectly clear that a knowledge of engineering or natural science is always extremely valuable in forming proper judgment on the action of materials under all the different conditions to which they may be subjected, whether these materials are iron, steel, cotton or air. It follows, therefore, that in the conduct of any kind of manufacturing, a knowledge of civil or mechanical engineering, or both, provides an excellent foundation on which to base one's judgment of manufacturing operations or materials.

"Even salesmanship can be strengthened by a knowledge of engineering for I believe it to be a basic fact that engineers, if they amount to anything, must acquire the habit of being honest with themselves as well as with others, and therefore the arguments in favor of the product which they may sell should be and I believe generally are, based on facts, rather than on selling points, thus resulting in a stronger position as a salesman and a more lasting contact with the purchaser.

Applying Technical Data to Industry

Still another application of engineering principles to manufacturing processes is found in the experience of Frank T. James, executive engineer of Lord & Taylor, large department store in New York City. Before his association with Lord & Taylor, Mr. James was for ten years engaged primarily in bridge construction work in the Philippine Islands. When he returned from the Philippines he felt that the department store might offer as good, if not a better field for his work than either consulting or construction work. He communicated with a dozen of New York's large mercantile establishments, letting each know of his technical background. Five firms asked for further information as to how he could direct a technical experience to their uses. He made an association with Lord & Taylor and has been with them for a number of years.

During Mr. James' first association with the mercantile house he studied the business thoroughly. The preliminary steps were then made toward the creation of the position which he now occupies, that of executive engineer. Practically the first work of an engineering nature which he did was to make a thorough analysis of the power plant of the building. He changed from a high-pressure steam generating plant to 100 per cent electrification, purchasing all current and steam, the latter for heating, hot water and cooking only, thus changing the plant from a high-pressure to a low-pressure one. By this change, what the company then considered rather a large appropriation for new equipment has been turned into a large annual saving in operation of the plant, The expense of making the change to electrification was saved practically in the first year of operation; and the number of men has been reduced from 23 to 5. Mr. James charges but 10 per cent of his salary to the building's power plant, the rest being charged against a number of manufacturing adjuncts.

Though Mr. James has made very flexible and economical of operation the power plant of Lord & Taylor, the company feels that equally as great a service which he has done is in putting on a self-sustaining basis a number of manufacturing and alteration workrooms which are a necessary complement of a large mercantile house. These plants include the manufacture of women's coats and dresses, millinery, upholstered furniture, stationery engraving, and alteration of the same, shoe repairs, glove repair, etc. Before Mr. James joined Lord & Taylor, these shops were operated as necessary ad-

juncts but few of them had been self-sustaining. This he accomplished by an analysis of the amount of material, labor, overhead, cost and depreciation of the equipment entering, let us say, the making of a garment and not deviating greatly from that exact specification. In other words, he explains, it was merely the application of the principles an engineer uses in estimating and construction to the manufacture of merchandise.

A New Engineering Service

Leaving this particular aspect of engineering in industrial plants, we come to an outstanding use of technical information and men which is best explained by outlining the condition at the Baldwin Locomotive Works in Philadelphia.

A few years ago the Baldwin Locomotive Works had received so many requests from its customers in foreign countries relative to prices and purchasers of materials other than for locomotives, and the opportunity to introduce and increase the sale of domestic products became so apparent that the company decided about six years ago to establish an engineering specialty department. This department is best described by quoting from the Locomotive Data Book for 1923:

"Of late our efforts to be of service to our friends in foreign countries have assumed a new form, that of utilizing the abilities of our trained engineers and purchasing agents in procuring for our clients, engineering products that are not of our manufacture and are not immediately related to the ordinary course of our business. Engineering products thus procured by us in discharging the commissions with which we may be entrusted are vouched for by the same guarantee that stands back of the output of our works; and no effort is spared to secure for our customers materials and supplies of the most approved kind. We believe that in this manner our purchasing and engineering organizations can be of great assistance to those who do not possess their own facilities for investigating the markets of the United States; and we are glad to undertake for our clients commissions for the supply of engineering products of every description."

That service has been enlarged recently so that now not only investigations as to the purchase of materials are made but consulting civil engineering practice of a limited degree is carried on for the sake of these clients. Chief among the employees of this engineering specialty department is an associate member of the American Society of Civil Engineers who spends most of his time upon civil engineering subjects, particularly those involving structural design. With its present extended service, therefore, this department will draw plans and specifications, for instance, for a whole water-works upon even meager cable advice. In at least one other instance, *Engineering News-Record* has discovered a like service offered South American clients. The latter service is offered by a shipping concern having no direct contact with the civil engineering or construction field.

In conclusion, it can be said that from the investigation made by *Engineering News-Record*, American industry is well served by engineers in executive positions. In many instances, it is found that they direct the purchases of not only non-mechanical but mechanical and engineering material and equipment. In all cases, they represent a tremendously important factor in the control of raw material and equipment buying and dispersion of finished product.

Tests of Welded Trusses and a New Truss Joint

Roof Trusses 40 Ft. in Span and 10 Ft. Deep Using New Insert Plate Joint Tested Under Three Times Design Load

By H. H. Moss
Linde Air Products Co., New York, N. Y.

During April and May of this year tests were conducted at the Buffalo shops of the Linde Air Products Co. on four oxyacetylene welded Fink roof trusses and one riveted Fink truss, all of 40-ft. span and 10 ft. deep. The results of the tests were given in a news report in *Engineering News-Record*, May 20, 1926, p. 826, but are here given in more detail. They show (1) that the welded trusses were more rigid by approximately 15 per cent; (2) that the welding did not inject negative factors of strength in the complete truss structure nor in the base metal adjacent to the weld; (3) that a material saving in weight of steel necessary for this type of structure can be made as a result of welding (by using nearer to the theoretical amount of steel in the members); and (4) that a member connection known as an insert-plate joint is a step in the right direction for joining structural steel by oxyacetylene welding.

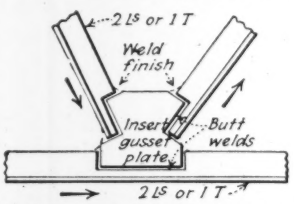


FIG. 1—DETAIL OF INSERT PLATE JOINT

Prior to the tests a preliminary truss was made up in order to check in a complete structure results that had been found over a number of years by testing of different types of joints and also to determine what new difficulties, if any, there were in the erection of a welded truss. The results for this preliminary truss are given in the accompanying table. Using them as a basis, the remainder of the tests were planned.

A riveted truss was purchased of the same type as the preliminary truss, designed to carry a given deadload. Using steel from the same heat, three welded trusses were made up, two with angle members and one with tubular members. The first of these three welded trusses was made up of the same sized members as the riveted truss and weighed practically the same. It is No. 3 in the table. The second welded truss, shown in the table as symmetrical truss No. 4, used members nearer the theoretical sizes than was possible with the riveted construction. Both trusses had upper chords of 3x2½x¼-in. angles and lower chords of 2x2x¼-in. angles. For the third welded truss standard black pipe (upper chord 3 in. nominal size, lower chord 2½ in. nominal size) was used. Gusset plates ½ in. thick made up of 2¼-in. plates were used on the welded trusses while those on the riveted truss were single ⅝-in. plates.

Insert-Plate Joints—On all of the welded trusses the members were joined by a joint similar to that shown in Fig. 1. Such a design provides several advantages: (1) Center of gravity lines of the members converge exactly at the true intersection points; (2) all principal welds are placed at or very near the centers of gravity of the members; (3) the major portion of the welds functions in shear; (4) all metal is joined by butt welds; (5) all metal joints may be placed symmet-

SUMMARY OF RESULTS OF TESTS ON WELDED TRUSSES

Truss	Kind of Truss	Comparable Weight of Trusses	Max. Panel Load	Factors of Safety Developed	Average Deflection, 3,000 Lb.	Average Deflection, 6,000 Lb.	Panel Load of 9,000 Lb.	Max. Recorded Compressive Stress Lb. Sq. In.
1	Preliminary truss, welded	1,199 lb.	10,258 lb.	3 42	.28	.62	1 03	29,250
2	Riveted truss	1,161 lb.	9,000 lb.	3 00	.29	.635	Failed	29,000
3	Welded truss, similar to 2	1,079 lb.	10,318 lb.	3 44	.25	.585	1 095	32,000
4	Symmetrical truss, welded	1,079 lb.	10,043 lb.	3 34	.335	.695	1 13	30,800
5	Tubular truss, welded	916 lb.	8,877 lb.	2 96	.285	.655	Failed	32,300
6	Tee truss welded	912 lb.	9,885 lb.	3 30	.265	.585	1 295	29,300

NOTE.—No. 6 was made after main tests, make-up, upper chord 2 angles 3x2½x¼, lower chord 1T 3x3x⅜

rically in regard to the axial plane of the main structure; (6) it is easy to round out the weld ends with fillet finish as shown by the dotted lines in Fig. 1, thus avoiding abrupt angles.

Welding Procedure — After experimenting with several procedures, the following was adopted: First, weld the insert gusset plates into the principal truss members; next, assemble the partially welded members and the remaining web members into the truss form, clamp together and weld. The final welding progressed from joint to joint. By the aid of a cardboard angle templet, proper alignment of the truss was

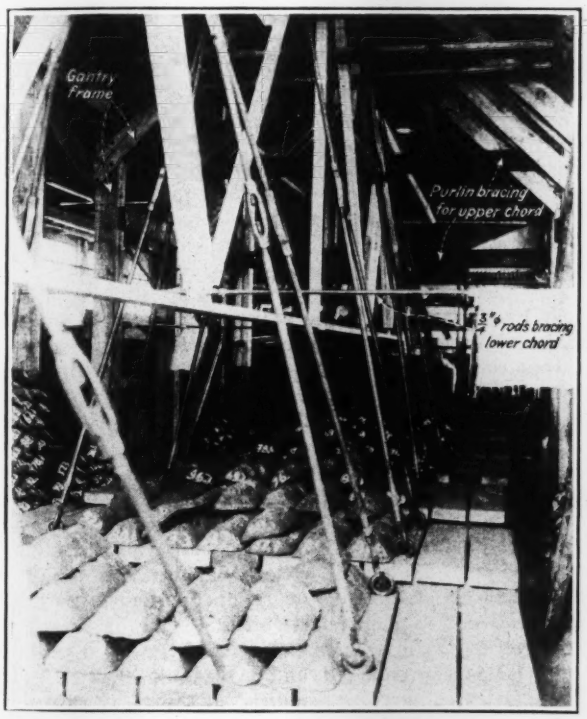


FIG. 2—WELDED TRUSS UNDER LOAD IN TEST STRUCTURE

maintained. Whenever two ¼-in. insert plates were used at each joint, double-vee welding was approached, since each half-truss after being welded throughout on one side was turned over and again welded on the opposite side.

Test Procedure—The design of the trusses contemplated that they be spaced 15 ft. to withstand a load of 40 lb. per sq.ft. of horizontal projection. All loads were disposed vertically at each panel point, the designed load according to the above conditions being 3,000 lb. at each panel point. The test structure consisted of hanging platforms for the loads, a purlin construction for holding the panel points laterally and timber gantries of 8x8-in. members secured to the concrete floor by expansion sleeve anchor bolts. A typical truss under test is shown in Fig. 2. Each truss was set on rocker supports on two concrete piers, one of which was fitted with a roller expansion bearing above the rocker. Eight-inch channel purlins secured the top members laterally, while two ⅞-in. round adjustable rods were used for holding the lower chord. After each increment of load was added, with the consequent

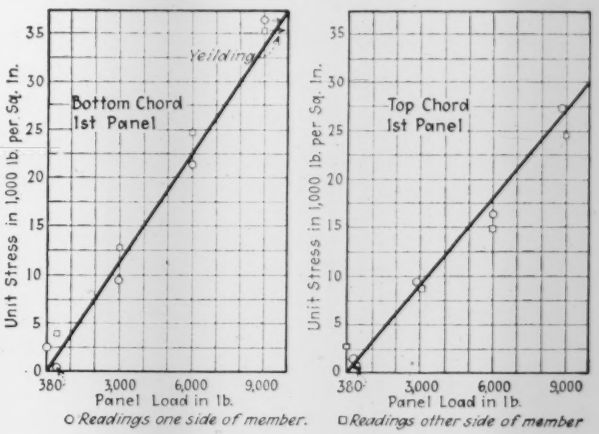

Unit Stress in 1,000 lb. per Sq. In.
Bottom Chord 1st Panel
Yielding
Panel Load in lb.
○ Readings one side of member.
Top Chord 1st Panel
Panel Load in lb.
□ Readings other side of member

FIG. 3—COMPARISON OF THEORETICAL WITH MEASURED STRESS IN TRUSS MEMBERS

Results shown for upper and lower chord of first panel of preliminary truss No. 1. Note how closely strain-gage readings approximate the theoretical straight-line stress curve to failure; this is typical of all trusses and members tested.

deflection of the chord members, the purlins were returned to level before placing the next load increment. Truss deflection was measured against a tightly drawn steel wire secured to the gusset plates at either end of the truss.

Strain-gage readings were taken on both sides of each member of each truss in order to determine the effect of residual welding stresses in such a structure and to study its elastic action. Typical stress values for the chord members of the first panel of the preliminary truss are shown in Fig. 3. The conformity of the plotted values to the theoretical straight-line stress is typical of all members tested. Readings were taken as indicated with panel loads of 3,000, 6,000 and 9,000 lb. In addition, readings were taken under no load and also with the hanger straps and platforms in place equivalent to 350 to 400 lb. per panel. The plotted stresses are the average of determinations made on three gage lines located at both the extreme fibers and the center of gravity of the member. The stresses were measured at the center of the members midway between panel points.

Test Results—In each truss typical column failure of the upper chord occurred between panel points; three failed at the rigid end of the truss and two failed at the movable end. The results are given in the accompanying table.

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Dust Collector for an Asphalt Plant

TO ELIMINATE the dust nuisance incident to an asphalt paving plant, and thus avoid the necessity of removing the plant, a combined dust trap and air washer was devised by Harry C. McClure, city engineer of Flint, Mich. As a residence district grew up around the plant the complaints increased and since it was not desirable to move to another location it was necessary to find some effective way of preventing the escape of dust. The successful result is indicated by Fig. 1, the view being taken with the plant in full operation but showing only a little dust at the head of the elevating conveyor and smoke from the tar kettles.

This air washer (constructed as shown in Fig. 2) consists of a dust box 23½ ft. square and 8½ ft. high, made of 1¾-in. dressed and matched lumber entirely covered with roofing felt. The interior is divided by partitions to form a continuous passage about 4 ft. wide and with a length of more than 100 ft. from inlet to outlet. In the first, third and last passageways is a series of spray nozzles. Just back of these nozzles are baffle boards to help collect and deflect the moisture and dust, other spray nozzles being so placed as to wash the baffles. The top of the hot elevator, the area over the mixer and the outlet from the drier, dust house and heaters, were all connected by a conduit led to the top of one corner of the dust box. At the diagonally opposite corner is a fan connected to a 30-in. steel stack 80 ft. high, as shown in Fig. 1. At first the spray piping was connected to the city water service but it is now served by a centrifugal pump taking water from a creek and delivering 300 gal. per minute. Sets of four

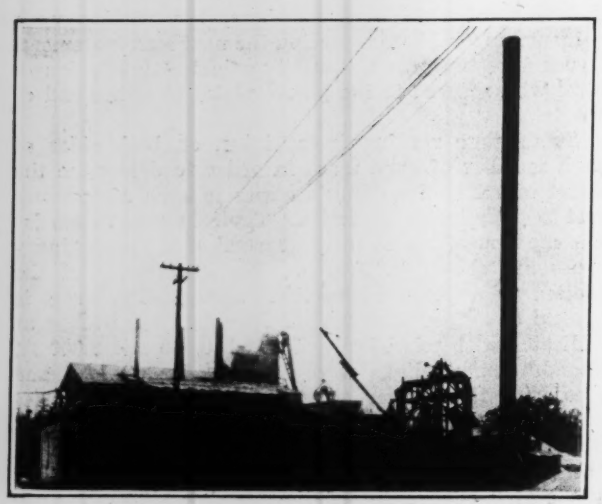


FIG. 1—DUSTLESS ASPHALT PLANT IN OPERATION

or six nozzles spray the dust and soot in the passage ways, while pairs of nozzles wash down the baffles. In all, there are 46 spray nozzles.

It was found that a great deal of dust settled out in the first two passages, being the heavier material drawn

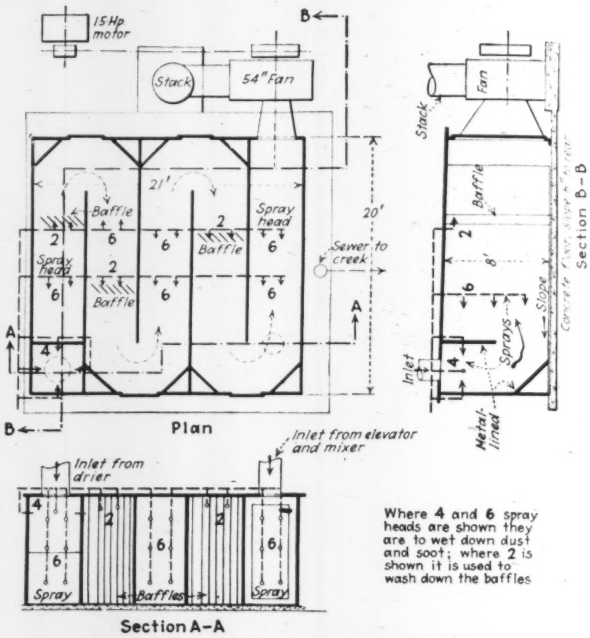


FIG. 2—AIR-WASHER AND DUST COLLECTOR

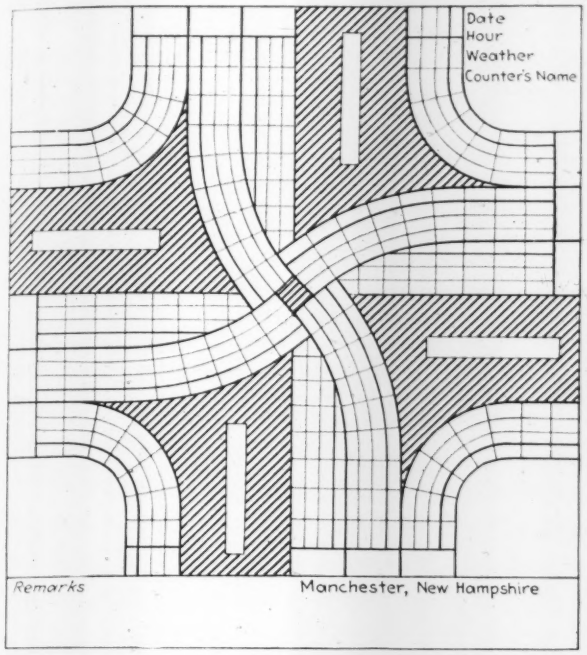
over by the fan, while the soot and very finely divided material was brought down at the last bay. It was necessary to line the first passage for some distance with sheet metal and put in additional spray heads, because of the heat, which caused a small blaze soon after operation was started.

Excellent results have been obtained, the air washer collecting from seven to twelve tons daily when the plant is producing top material or binder, respectively. Formerly practically all this material was discharged into the open air, as the cyclone dry-dust collector was inefficient in handling the very finely divided material produced at this plant. Only about 6½ gal. of water are required to wash down a pound of dust. The washed material is shoveled out and is used in the top mix, being practically all pure silica, as the clay is carried off to the creek by the wash water.

Tally Sheet Aids One Man to Record Street Intersection Traffic

By William L. Hyland
Care of Fay, Spofford & Thorndike, Boston, Mass.

A TRAFFIC survey was made recently in Manchester, N. H., to serve as a basis for immediate improvement in regulation and control of traffic, and to aid in the design of a major traffic street system. For this census a new method of keeping track of cars was devised, requiring the use of a traffic tally sheet, copyrighted by W. L. Hyland, formerly assistant engineer, Manchester Highway Department. This method is designed to aid one man in counting the number of vehicles passing through a street intersection. By its



SHEET FOR ONE-MAN RECORD OF VEHICLE TRAFFIC

use one man can record: (1) The number and direction of turns made at an intersection; and (2) The total number of vehicles going in each direction on each of the four streets entering the intersection.

The tally sheet is symmetrical, and represents the four streets entering a street intersection. The right-hand half of each street entering the intersection is subdivided into three lanes, representing the three possible routes which a vehicle may take on arriving at the intersection. On the extreme right is indicated the right turn, next (to the left) is the left turn, and next (to the left) is the straight ahead route. Cars taking these routes are to be designated in their respective lanes by the pencil mark of the recorder. The lanes are cut up into small sctions for convenience in counting the pencil marks. The small rectangular spaces in the center of the four black areas are for noting the names of the intersecting streets. A white sheet is used for pleasure cars and a yellow sheet for trucks. A new set of sheets is started each hour. The sheets are arranged alternately, first a white one then a yellow, in a post binder and it takes but a second at the end of the hour to turn over to a set of new sheets. With the aid of the tally sheet one man has successfully recorded vehicular flow at the busiest intersections, and has checked as many as 1,100 vehicles in an hour, with the correct designation of turns for cars and trucks.

In this work we have found it necessary to employ men of average intelligence, and have had success with conscientious workers who have gone through high school. It is possible to check results occasionally by placing counters at adjacent intersections, where the counts ought to be the same for the one connecting highway. After a short experience with the tally sheet the counters have become quite expert, and have been able to get results on intersections having very irregular street approaches.

Building Up the Laborer's Interest in Construction Work

By G. W. Maker
Aberthaw Co., Boston

IT HAS been quite easy to teach our field executive forces to watch progress of their work, but it has not been as easy to teach this to the mechanics and laborers who ordinarily do not readily understand and are not particularly interested in such matters as progress

THERMOMETERS RECORD PROGRESS OF CONCRETING GANG ON BOSTON BUILDING JOB

charts. About a year ago on a contract which involved the placing of a large yardage of concrete, we were very successful in creating an interest in progress throughout the gangs by the use of a sign painted to imitate two thermometers side by side, one of these showing the yardage of concrete it was necessary to place each day in order to maintain scheduled progress, the other showing the actual yardage placed each day. These thermometers were brought up to date each morning by the application of a little red paint.

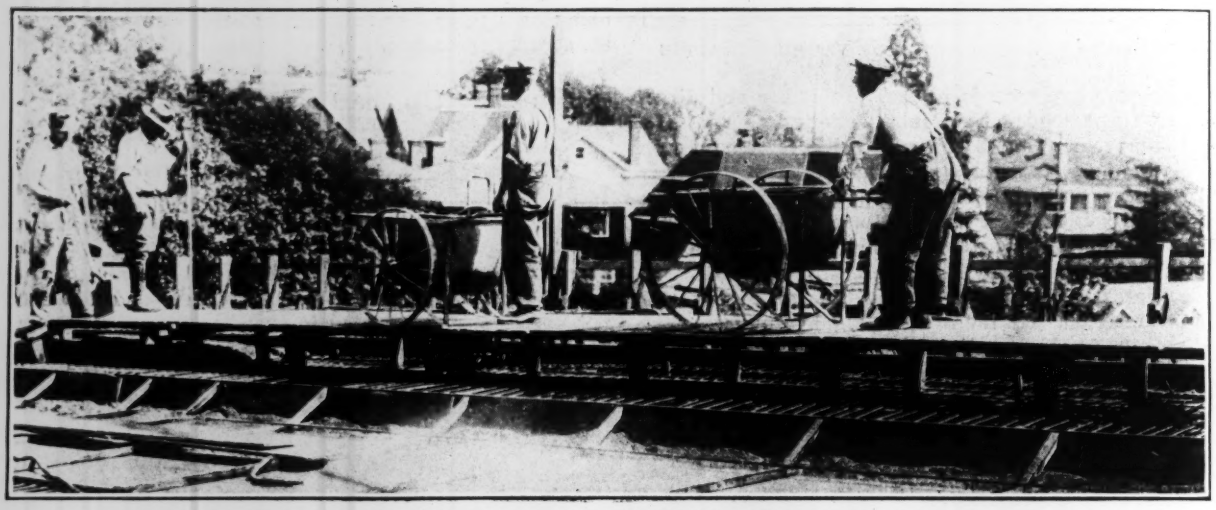
This was so successful in creating an interest in progress that we are using it on other concrete jobs, one of which is shown in the accompanying photograph. Incidentally this thermometer sign has attracted a very great deal of attention and has proved to be a good advertisement for the company.

"Duck Boards" Useful in Pouring Concrete Bridge Floor

IN pouring the floor slabs of the Vista Ave. arch bridge in Portland, Ore., concrete was delivered in buggies from a mixing plant at the upper end of the bridge. The 7 per cent grade on which the bridge is built speeded up the delivery of the loaded buggies and made hand delivery the preferable method.

When time for concreting came, in order to get the buggies to the desired point of delivery without interference with the floor system reinforcing the contractor used runways built up in sections which consisted of 1-in. boards about 4 ft. long transverse to the line of travel and held together by longitudinal cleats. Sections of this runway about 6 ft. long were supported on short tapered lengths of 4 x 4's, as shown in the accompanying picture. These were dubbed "duck boards." They were very convenient in that being light they could be moved about quickly. An extra section alongside the main runway provided a passing point and a section from which the legs on one end had been removed constituted a ramp or inclined approach to the runway.

These duck boards have also been used successfully on several other jobs by Parker & Banfield, contractors, Portland, Ore.



"DUCK BOARDS" USED FOR DELIVERING CONCRETE OVER REINFORCING IN PLACE

From Job and Office

HINTS THAT CUT COST AND TIME

Diagram for Flow Through Venturi Meters

By R. T. Regester
Junior Civil Engineer, Bureau of Sewers, Baltimore, Md.

IN the hydraulic design of water-works and sewage-works where the available head for gravity flow through the plant is greatly limited, relatively small losses of head require consideration. It is, therefore, necessary to study carefully the effect of various units upon the hydraulic gradient for fluctuating flows. In the case of Venturi meter tubes the head requirements for any flow may be obtained quickly from the accompanying diagram. The chart applies to cast-iron tubes of the Builders Iron Foundry type and standard sizes in which the ratio of throat to inlet diameter varies from $\frac{1}{3}$ to $\frac{1}{2}$.

The scale for total lost head, h in feet, is based upon the generally used equation for water, $h = 0.00168\ v^2$, in which v is the throat velocity in feet per second. Should the designer prefer to use other data, in the form h equals a constant times v^2, a multiplier $k =$ constant divided by 0.00168 can be readily applied to the values given on the diagram. For instance, in the Catskill Aqueduct design the formula used was $h = \frac{0.14}{2g} v^2$ ("Waterworks Handbook": Flynn, Weston, and Bogart, p. 583), and the value for k would be 1.30.

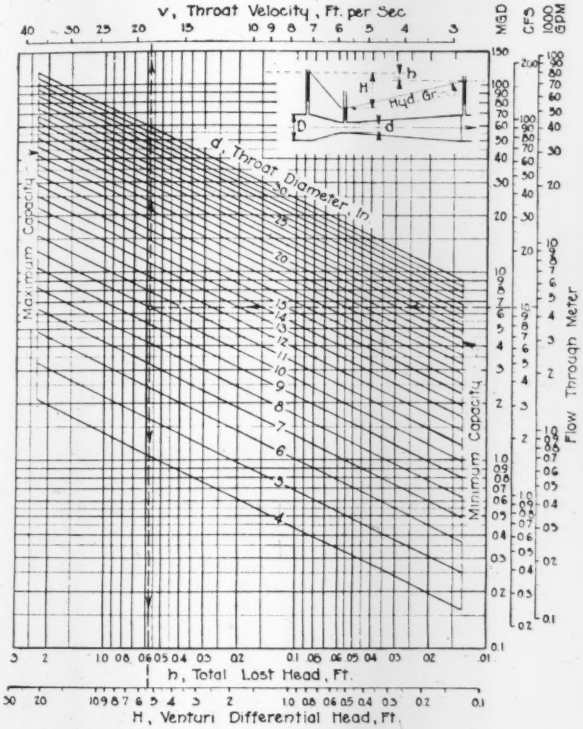
The Venturi differential head, H in feet, has been given so the elevation of the meter with respect to the hydraulic gradient may be readily selected to give positive head on the throat. These values for H are obtained from an approximate form of the basic discharge equation which has been so compensated that the error, about 3 per cent, will be negligible.

As an example, assume a flow of 4,500 g.p.m. through a tube having a throat diameter of 10 in. By following the arrow lines on the diagram it will be seen at the bottom scales that the lost head $h = 0.57$ ft., and the differential head $H = 5.3$ ft. Referring to the top

From Job and Office

FOR CONTRACTOR AND ENGINEER

scale the throat velocity will be about 18 ft. per second. If the ends of the diagonal line for throat diameter are projected horizontally to the vertical scale for flows, the lower and upper points will give the minimum and maximum recommended capacity of the meter, respectively. These values are for the mercury-column-



RELATION OF HEADS TO WATER FLOW FOR STANDARD VENTURI METERS

operated standard register; if lower differentials are required, water-column-operated registers are generally used where the hydraulic gradient permits. The range for a 10-in. diameter throat will be from 1 to 13 m.g.d.

Acknowledgments are due to C. E. Keefer, engineer of sewage disposal, and Prof. John H. Gregory, consulting engineer, Baltimore, Md., for helpful criticism.

Pile Hammer Breaks Up Aqueduct Masonry Obstructing Sewer Construction

THAT section of the Baisley Boulevard sewer, now building, which runs from North Conduit Ave. to Long St., South Jamaica, Borough of Queens, New York, encounters an aqueduct and two 48-in. pipes which carry part of the water supply to Brooklyn from Long Island. At this point, the aqueduct crosses a stream and it was necessary to remove the aqueduct temporarily in order to build the siphon for the new sewer, which will drop 12 ft. below the base of the new aqueduct. At this point during the construction of the siphon the water from the old aqueduct was diverted into a temporary bypass. The old aqueduct was 13 ft. wide, 10 ft. high, and 137 ft. long, and was built of brick and concrete and finished on the outside and top with heavy granite blocks.

When demolition began it was discovered that the masonry was in excellent condition, consequently difficult of removal with hammer drills. As explosives were not permitted because of the proximity of the temporary water line, the masonry had to be chipped out. The contractor found hammer drills rather slow and tedious so he made use of a steam pile hammer in the

PILE-HAMMER BREAKING UP AQUEDUCT MASONRY

base of which was fitted a cap which served as a chuck for supporting a long 4-in. chisel of the bull-point pattern. With the aid of this device the granite blocks and the masonry fill behind it were broken out in mass. The spoil was then removed with a bucket operated from a continuous-tread tractor crane. By this specially rigged pile hammer, a total of 600 cu.yd. of masonry was broken up in a much shorter period than the contractor had estimated for the work.

The contractor doing this section is the Necaro Co., Brooklyn, N. Y., from whom, together with the McKiernan-Terry Co., whose No. 6 pile-hammer was in use on the work, material for this article was secured.

Job and Office Notes

Superiority of Welded Joints in Piping Subjected to Intense Heat was brought out in investigation of the property of an oil company in California after thirteen 55,000-bbl. tanks and six 1,000,000-bbl. underground reservoirs had been destroyed by a fire started by lightning. According to information given by the *Oxy-Acetylene Tips* for October, in joints made by oxwelding there was no failure whatever, though screw-coupled piping in the fire-swept area, even underground, pulled out of fittings and couplings and other couplers and fittings warped or split, allowing the joints to separate. Many fittings collapsed entirely. For instance, in a 10-in. oil line the threaded flange connection at a valve pulled loose, but the butt weld a foot away and the welded tee 4 ft. away withstood the fire. Again, in the connections to a booster pump, all the fitting connections failed, the cast-iron ell having collapsed completely, yet all the welds in the steel pipe remained intact. Inasmuch as the screw couplings on the elaborate piping systems for fire-fighting compounds failed, the system itself failed to check small fires which later became destructive through their igniting the large tanks, resulting in large property loss.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

Am. Soc. C. E. Surveying Division

Sir—I note that your only reference to the new section of the American Society of Civil Engineers on surveying and mapping occurs on p. 629, *Engineering News-Record*, October 14. You give some of the older sections special notice. I feel that your comments on p. 629 are unfortunate and unjustified. I attended the meeting of the section on surveying and mapping. The room was crowded while the papers were being read. At one time there were several men standing. Three excellent papers were read. Your informant was not present, evidently, since all who heard the papers were euthusiastic and none of these would say that the section "was attended very sparsely." In fairness to those who prepared and read the papers, to those who are members of the new section and in order that your report of the meeting may be in closer agreement with the facts, some correction should be made.

CLARENCE T. JOHNSTON,
Professor of Geodesy and Surveying,
Ann Arbor, Mich. University of Michigan.
Oct. 18, 1926.

[The Society headquarters reports that the attendance at the section is recorded as 80.—EDITOR.]

Bats to Combat Mosquitoes

Sir—Your editorial note of Sept. 30, entitled "Mosquito Triumphans," concludes thus: "The pure science which theorizes on the mosquito may be basically correct; the practical results of that theorizing are a lamentable failure."

From this statement and what precedes it I judge that you are looking for a method that will actually keep down the mosquito pest to such an extent that their numbers will be insignificant. Such a method has been found after a quarter of a century of extensive investigation by Dr. Charles A. R. Campbell of San Antonio, Texas. It consists of building houses or roosts for the propagation of bats, which animals are the principal natural enemy of the night-flying mosquitoes. As you know, it is a species of these that carries malaria; and Dr. Campbell has been able to obliterate that fell disease entirely from the vicinity of one of the worst pest-holes in America, Mitchell's Lake, situated some ten miles south of San Antonio and receiving all of its sewage.

About a year ago The Stratford Co. of Boston issued a book by Dr. Campbell describing his numerous experiments upon the extermination of certain insect-borne diseases, under the title "Bats, Mosquitoes, and Dollars." This treatise has been reviewed all over the world, mainly in the engineering and scientific press; and almost invariably it has met with enthusiastic approval, although there were, of course, a few doubting Thomases. (See *Engineering News-Record*, Nov. 19, 1925, p. 847.)

I am able to and do vouch for the correctness of every statement and claim in the book; because, for the last twenty-one years I have followed continuously with intense interest all of Dr. Campbell's investigations—in fact, the publication owes its existence to me, in that it was I who, by reiterated pressure extending over several years, induced the good doctor to write it. I am of the opinion that, if bat roosts were properly constructed and populated along the mosquito-infested portion of the Atlantic Coast, the night-flying mosquitoes would be kept down to an insignificant number and there would soon be no malaria there.

There is a question that Dr. Campbell has not yet settled; the area which one of his bat roosts, when fully populated, will protect. It can be solved in only one way—by trial on a large scale. For instance, if a line of roosts twelve miles apart were built along the cost several miles back from the water, and if these were to prove insufficient, intermediate roosts could be erected.

It must not be forgotten that these roosts would produce enough guano for fertilizer to pay interest on cost of construction and for any small repairs there might be. Dr. Campbell secures fully two tons of it per annum from his Mitchell's Lake roost, and he sells it at from 5 to 10c. per lb. It is said no commercial fertilizer is its equal in efficiency.

Dr. Campbell points out in his book how the daylight mosquitoes can be kept down by the propagation of dragon-flies, but his experiments in this line were not carried to conclusion, as were those on the bats. He indicates, however, in what way the work he did could be advantageously extended. The daylight mosquito is an infernal nuisance; but, so far as I know, does not in this vicinity transmit any kind of infection, since yellow fever has been wiped out; but its extermination would be a god-send to many people.

If the American people in the mosquito-infested districts will purchase Dr. Campbell's book, study it carefully, and then adopt the method of action it portrays, I am confident that in a few years they will be relieved of both night-flying mosquitoes and malaria.

J. A. L. WADDELL,
New York City, Consulting Engineer.
Oct. 5, 1926.

Concrete 19-Story Apartment at Detroit

Sir—In the description of the 19-story apartment building, in your issue of Sept. 16, p. 458, no loading is given. As most of us are not familiar with the Detroit building code, it would add to the value of the article if you would publish the loading for the roof and various parts of the floor.

JOHN H. RYCKMAN,
Chicago, Ill., Structural Engineer.
Sept. 23, 1926.

Sir—With reference to the live-loads in the desigin of the Detroit Towers apartment building, the following is taken from the Detroit Building Code: "Live-load for roofs, 30 lb. per sq.ft.; for apartments, 40 lb. per sq.ft.; for apartments (places of assembly), 80 lb. per sq.ft.; for stairs and landings, 100 lb. per sq.ft.

"Walls, piers and columns of all buildings except as noted shall be designed to carry the full dead-loads and not less than 85 per cent of the live-load on the top floor; 80 per cent of the live-load on the next floor below and so on, reducing by 5 per cent the live-load on each succeeding floor until 50 per cent of the live-load is reached, after which each succeeding floor shall be figured for at least 50 per cent of the live-load coming on same."

W. S. WOLFE,
Detroit, Mich., Smith, Hinchman & Grylis.
Oct. 1, 1926.

An Answer to a Lightning Query

Sir—The experience which Samuel P. Baird, of Cleveland Springs Co., Shelby, N. C., mentions in your issue of Oct. 14, p. 638 is not entirely novel; at least of the observations of certain lightning-rod contractors are to be accepted as correct.

One of them recently told me of an instance wherein there was a water pipe running into a house, conveying water from a spring about a quarter-mile away. There was no metallic connection from this pipe to any other part of the building or its furniture. During a thunder storm, a flash was seen to jump from the faucet on the end of the pipe to a stove nearby.

The theory of the lightning rod men seems to be that when a charge collects in a given area of the earth, it attempts to discharge in any direction to an area of lower potential. If the entire charge is not spent in an interchange with the cloud over the charged area, other portions of it will discharge along water pipes and any other available conductors until the tension is entirely relieved.

Or if, contrary to the presently most popular theory, the discharge is actually from cloud to earth, and not from earth to cloud, then the area receiving the discharge would naturally spread it out over all available conductors until no further tension existed, and the shock felt by the men working in the trenches was caused by this spreading out.

The pipes, of course, conducted their portion of the discharge so much more readily than the dry earth surrounding them that a difference of potential existed. The bodies of the men being only moderately good conductors, they felt a shock as they conducted the current from the pipes to the ground.

CHARLES F. DINGMAN,
Palmer, Mass. President, Palmer Construction Co.
Oct. 16, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Why Ashokan Reservoir Storage Is Low

Official Reply to Daily Paper Story Alleging Heavy Leakage from New York Reservoir

On Monday (Oct. 25) the *Herald-Tribune* of New York City printed a front-page article entitled "Ashokan Water Ample, but Leaks Drain City's $160,000,000 Reservoir." The declaration purported to be "the substance of competent engineering opinion" obtained by the daily named "in a recent survey of New York City's water system."

Inquiries made by *Engineering News-Record* of Thaddeus Merriman, chief engineer Board of Water Supply, New York City, and of W. W. Brush, deputy chief engineer of the Department of Water Supply, Gas & Electricity (the reservoir having been built by the board as a part of the Catskill system and now being operated by the department) brought declarations that there is no material leakage known to exist. Mr. Brush states that the depletion of the reservoir is due to heavy drafts made to lessen pumping from other sources of supply, combined with runoff to the reservoir of late which is below normal, although still high compared with the Croton runoff.

Mr. Brush Replies

Below is printed in full a reply to the *Herald-Tribune* article, prepared by Mr. Brush on Oct. 25 for the New York press, supplemented by rainfall figures from Mr. Brush requested by *Engineering News-Record*. Referring to the *Herald-Tribune* article Mr. Brush says:

"This article makes the following statement:

'Not because of lack of rain, as is commonly believed, . . . but because, by a curious phenomenon of nature, . . . the water supply upon which New York is dependent for its life and health is finding its way out through the floor of the basin into subterranean veins and thence to the surface again in adjacent water courses.'

"Further on in the article it is stated:

'Measurements of the flow of the Esopus taken on Oct. 15 refute these figures, however. On that date the stream was flowing under the bridge at Coldbrook at a rate that would indicate delivery to the Ashokan, two miles below, of no fewer than 800,000,000 gal. of potable water every 24 hours. The stream at this point is approximately 200 ft. wide, averages 2 ft. of depth, and was flowing at a speed a fraction under 4 ft. a second.'

"Still further, the article states, that the Esopus at Legg's Mill and at Glenerie Falls is an impressive stream, intimating that this stream is fed by the leakage from the Ashokan Reservoir.

"Water was first stored in the Ashokan reservoir in September, 1913. From that time to the present there has been no evidence of leakage from the Ashokan reservoir other than the expected slight seepage through the Olive Bridge masonry dam, except that at the east end of the east basin there was some seepage through two small earthen dikes. This seepage only occurred when the reservoir was practically full, and the Board of Water Supply grouted these dikes to cut off the seepage. The bottoms of these two dikes are many feet above the water level now in the East basin.

"The falsity of the statements made of an alleged leak of several hundred million gallons from the Ashokan reservoir is shown by the following:

"1. The rainfall on the Esopus watershed is measured at ten different gauging stations scattered throughout the watershed. The average rainfall for the year during the past twenty years has been practically 48 in. The water represented by this rainfall, which in-

(*Continued on p. 721*)

Engineering Fifty Years Ago

From *Engineering News*, Oct. 28, 1876

FOUR projects are on hand for crossing the East and North rivers. These are, the Brooklyn bridge, 1,600 ft. clear span; the Poughkeepsie bridge, 1,630 ft.; the Blackwells Island bridge, two spans, 1,270 ft.; and the Hudson River tunnel, 10,000 ft. long. The cost of the Brooklyn bridge will be over $13,000,000, and the Hudson River tunnel about $15,000,000, according to the estimates. The company has $10,000,000 capital. The suspension bridge over the Hudson will have of entire length, 2,230 ft.; distance between centers of towers, 1,680 ft.; clear span, 1,630 ft.; clear height above water, 165 ft.; railway grade above water, 190 ft.; and height of towers above water, 340 ft.

Earthquakes Rock San Francisco

San Francisco and vicinity was shaken by several earthquakes early on the morning of Oct. 22, three shocks being recorded about an hour apart. The center of the disturbance according to records on seismographs at the University of California, was estimated to be about 70 miles to the southwest which would place it under the Pacific Ocean. The intensity at San Francisco on the Rosi Forel scale was about 4. Structural damage consisted principally of plaster cracks and broken plate glass in several large windows along Market Street.

Dallas Projects Call for $40,000,000 in Bonds

Extensive Public Works Program Planned Over 10 Years—Railways Active

For an extensive program of public works the city of Dallas, Tex. is planning a bond issue of nearly $40,000,000 to cover storm sewers, water supply, sanitary sewers, sewage disposal, street paving, street widening and extensions, schools, parks, art gallery, library and public market. The City Plan Commission is making a survey of the situation and alloting certain amounts to each of the above items, permitting the people to vote on individual projects. If the bond issue is aproved, the city intends to spread the amount over a 10-year period without increasing the present tax rate. The City Plan Commission proposes also to ask the legislature for an act enabling municipalities to pass zoning ordinances.

Following the approaching completion of the Garza Dam, there will be a call for additional funds to rehabilitate the city's pumping plant and also to provide for large cross connecting water mains.

An additional sewage disposal unit is needed farther down the Trinity River to take care of the gravity flow of the rapidly growing southern city limits. Garbage collection and disposal is scheduled for a re-arrangement in order to handle it from the rapidly growing suburbs and the present plan calls for the erection of three new incinerators. The flood protection project will necessitate a number of new bridges and viaducts across the new river channel. This project will also call for much additional work in the way of new streets, sewers and water services.

Railway Projects

In the line of private enterprise, the Houston & Texas Central Ry. (Southern Pacific System) is building a new freight warehouse and its plans call for the opening and widening of several new streets and thoroughfares, with the creation of a large industrial district in a portion of the town that is at present very poorly developed. This may be the first step in the removal of company's tracks from Central Ave. The company has acquired a large tract of land to the south of the city and is building a large freight yard. The Texas & Pacific Ry. has completed its large East Dallas yard and it is rumored that the present city yard is to be remodeled and a new freight warehouse and office building erected. This improvement will permit the extension of Pacific Ave. to give Dallas another east and west thoroughfare. The St. Louis Southwestern Ry. has made improvements in its freight terminals and proposes the construction of a large freight yard.

San Francisco Bay Bridge Projects Total 17

Repeated Hearings and Some Detailed Studies Bring Situation Toward Final Action

The most exhaustive series of hearings yet held on proposed transbay bridges is now nearing conclusion before the San Francisco board of supervisors. This series, carried on intermittently in sessions held usually three or four days a week, has continued since early in September and early in October the last of the seventeen applicants completed their presentations.

After receiving all applications the supervisors voted to retain three consulting engineers to compare and report on the various projects, as was announced in *Engineering News-Record*, Oct. 7, p. 594. From time to time as previous transbay bridge hearings have been held this journal has published maps and tabulations summarizing the various projects. Two such summaries published last year appeared in the issues of July 30, 1925, p. 178, and Dec. 31, 1925, p. 1086, respectively. Another table listing the projects just presented as well as those whose applications were renewed, accompanies this article.

Some Applications Detailed

Some of the applications now before the supervisors have been presented only in a general way while others were worked out in considerable detail even to the making of test borings of foundation conditions. Some applicants did not disclose what financial support they had obtained; others did so in private to the supervisors, and a very few openly announced well developed financial plans, backed by financial organizations of high standing.

A franchise from the supervisors is not sufficient authority to build the bridge, there must also be obtained the approval of the War Department which is on record with a ruling as to its policy in the matter issued in 1921. It is believed that a modification of this ruling against any high-level bridge north of Hunter's Point might now be obtained, particularly if the interested communities could agree on some feasible and mutually acceptable plan.

San Francisco supervisors, it is believed, favor a bridge with provision for handling steam railroad traffic while Oakland is understood to want to leave undisturbed the East Bay railroad terminals. Adding provisions for all types of steam railroad operation to a transbay vehicular bridge is estimated to add about $25,000,000 to the cost.

San Francisco Bay Bridge Projects for Which Franchise Is Now Asked

Applicants	Engineers	Type of Proposed Structure	Location	Channel Crossing (135 Ft. Above Water Level Unless Otherwise Noted)	Other Main Spans	(1) Roadway Width; (2) Total No. of Tracks; (3) Total Length of Crossing	Estimated Cost, Millions Dollars	Construction Period Years
"Victory Tubes"* E. W. Davis	J. V. Davies R. Modjeski S. W. Taylor H. G. Burrowes	Combination bridge and tube, one R.R. and two vehicular tubes	Foot of Folsom St., S. F., to S. P. Oakland Mole	3,000-ft. channel, 50 ft. clear depth	High bridge including one 1,000-ft. span	40-ft. roadway; two R.R. tracks; 1,800 ft. shore to shore	75	4
Bay Cities Bridge Co. (A. J. Hanford, Pres.)	J. G. Little Chas. Derleth, Jr. A. J. Calder	High level steel trusses, double deck	Foot of 16th St., S. F., to foot of Pacific Ave., Alameda	One 1,000-ft. span; two 590-ft. spans	Forty-eight 250-ft. steel trusses	38-ft. roadway; two R.R. tracks, 22,750 ft.	20 single deck; 30 double deck	4
A. H. Bergstrom	John B. Leonard H. B. Hammill	High level steel trusses, double deck	Hunter's Point to Webster St., Alameda	Six 500-ft. spans	200-ft. spans; towers 50 ft. wide	60-ft. roadway; two R.R., 2 R. T. tracks, 6 miles	35 to 60	
"Sunshine Transbay Boulevard Bridge" J. E. Birmingham	J. B. Strauss	Cantilever spans and bascule	7th and Mission Sts., S.F., via elevated to Hunter's Point, thence to Alameda near estuary	1,050-ft. cantilever near S.F. side; 900-ft. span over estuary	20,400 ft. in deck spans	56-ft. roadway; one R.R., 2 R.T. tracks, 12 miles	65	5
Allen C. Rush	A. C. Rush E. L. Van der Nailen	Interlocking suspension	Foot of Mission St., S.F., to Goat Island, thence parallel to Key mole	Four 2,400-ft. spans; 200 ft. above water level		114-ft. width; four R.R. tracks, 16,600 ft.	45 to 60	
R. S. Chew	R. S. Chew	Three-truss, double deck cantilever	Telegraph Hill to Goat Island, thence parallel to Key Route mole	Four spans ranging from 1,380 to 1,850 ft. long; 180 ft. above water level	Eight 200-ft. spans; forty-nine 80-ft. spans	Two 36-ft. roadways; six R.R. tracks, 21,000 ft	50 to 70	5
San Francisco Bay Bridge Co. E. A. Bertram	E. A. Bertram	High level steel trusses	Foot of Folsom St., S.F., to S.P. Oakland mole	Six 1,500-ft. spans; two 1,000-ft. spans	Fourteen 715-ft. spans	Six traffic lanes; four R.R. tracks, 21,000 ft.		
O. A. Ellis	O. A. Ellis	Two parallel tunnels	4th and Harrison Sts. to 7th and Cedar Sts., Oakland	200 to 300 ft. below water level	Depth to be according to foundation conditions	24-ft. roadway; two R.R. tracks, 5 ½ miles	12	
Construction Co. of North America	A. J. Cleary J. J. Walsh C. W. Landis W. L. Huber	High level steel trusses, double deck	Rincon Hill, S.F., to S.P. Oakland mole	1,050-ft. cantilever span; 1,100-ft. span over estuary 147.5 ft. above water	Seven spans ranging from 200 to 600 ft.	58-ft. roadway; four R.R. tracks, 24,000 ft.	100	4
N. Y. and S. F. Development Co.	Geo. W. Goethals C. W. Otwell	High level steel trusses, double deck	Hunter's Point to Bay Farm Island	Four 750-ft. cantilever spans 140 ft. above water level	Forty-three 250-ft. spans	60-ft. roadway; two R.R., 2 R.T. tracks; 6 ½ miles	56 inc. R.T. 85 inc. R.R.	3 ½
"Air Line High Bridge"* R. C. Hackley	J. V. Davies R. Modjeski S. W. Taylor H. G. Burrowes	High level steel trusses	Pier 26 on S.F. side to S.P. Oakland mole	Two 1,750-ft. cantilever spans, 1,000-ft. span, over estuary	Chiefly 750-ft. spans	50-ft. roadway; two R.R. tracks, 18,300 ft.	100	4
P. L. Dunn†	D. S. Clinton M. K. Miller W. J. Fogelstrom L. H. Rand	Cantilever steel trusses, double deck	2nd and Folsom Sts. to Pacific Ave., Alameda	Four 750-ft. cantilever spans		40-ft. roadway; two R.R. tracks, 17,150 ft.	85	5
Intercities Bridge Co., A. O. Stewart, Pres.	Leonard M. Cox W. H. Burr C. E. Grunsky J. A. L. Waddell H. G. Butler	Braced tower suspension (towers, 250 ft. wide)	Foot of Broadway S.F., to Yerba Buena Ave., Oakland, via Goat Island	Four 1,550-ft. spans	Series of 300-ft. spans and viaduct	40-ft. roadway; four R.R. tracks, 21,000 ft.	56	6
G. Lindenthal	G. Lindenthal G. W. Goethals	Double-deck Steel trusses	South side of Hunters Point to foot of Webster St., Alameda	One 240-ft. span	14,000-ft. of double deck; 180-ft. spans on west end; 16,000 ft. fill on east end	40-ft. roadway two R.R. tracks, 30,000 ft.	25	2½
W. F. Holcomb†	M. K. Miller W. J. Fogelstrom L. H. Rand			Three 1,200-ft. spans		Seven traffic lanes five R.R. tracks, 19,330 ft.	70	5
Thos. E. Slaven						115 ft. wide; 19,700 ft.		
E. D. Bronson, Jr.*	J. V. Davies R. Modjeski S. W. Taylor H. G. Burrowes					110 ft. wide; 17,950 ft.	75	4

*† These applicants have combined.
R.T. = Electrically-operated rapid-transit lines. R.R. = Steam railroads.

Why Ashokan Reservoir Water Storage Is Low

(*Continued from p. 719*)

cludes snow and hail, as well as rain, is divided into two parts, one part representing the water that comes into the reservoir and is used by the city, and the other part the water that is evaporated through the vegetation and the action of the sun on the surface of the ground, and on the surface of the water. The part that has been used by the city has from 1919 through 1925 varied from 56.2 to 67.1 per cent, which is a very high average. During the same period on the Croton watershed, where no question has been raised about leakage from the reservoir, and where the yield of the watershed is determined in a similar manner, the percentage that has reached the reservoir has been between the low of 43.4 per cent and the high of 63.9 per cent. The average for the Esopus watershed for this period has been 61.2 per cent and for the Croton watershed 52.5 per cent. The average flow of the Esopus Creek is only 373 m.g.d., as determined by the water drawn from the reservoir for the use of the city, and the changes in the water level in the reservoir, and yet this represents over 60 per cent of the total rainfall on the watershed.

"On Oct. 15 [1926] the department figures showed that the stream flow into the Ashokan reservoir, less the evaporation from the surface of the reservoir, amounted to 104 m.g. for that day. The *Herald-Tribune* article states that the flow at Coldbrook was on that day at the rate of 800 m.g.d. If this be true, the leakage from the Ashokan reservoir on that day would be 700 m.g. and this rate of leakage would be two or three times greater when the reservoir was at the usual water level. This leakage would be at a rate several times the total water falling on the watershed throughout the year, without any water being evaporated. The absurdity of this is evident.

"2. At Coldbrook the Board of Water Supply has maintained a gauging station since 1914 where gaugings are taken generally twice a day. This gauging station is to determine approximately the flow of water in the stream, but the accurate determination is by the change in the reservoir level, and the measured flow through the Catskill aqueduct of the water drawn out for use in the city. From Oct. 1 through Oct. 15 the Coldbrook gaugings showed an average flow of 126.2 m.g.d. The flow of the stream, as shown by the reservoir measurements and the aqueduct flow, averaged 107.6 m.g.d. This is practically in agreement, as there is the evaporation from the surface of the reservoir to be deducted from the stream flow, and there is some stream flow to be added from the watershed that lies below Coldbrook. The flow at Coldbrook has been determined by measurements taken with current meters and careful cross-sections of the stream at this point. The width of the stream at the Coldbrook station, which is apparently the point where the *Herald-Tribune* representative attempted to measure the flow, was about 124 ft. on Oct. 15, as compared with the 200 ft. given in the *Herald-Tribune* article, and the maximum depth on the fifteenth was about 2 ft. with much less depth for the remainder of the stream section.

"There remains the statement that at Legg's Mills and Glenerie, the Esopus Creek was again a substantial stream on Oct. 15. This probably was so, as the watershed tributary to the Esopus below the Ashokan reservoir is about 161 sq.mi., as compared with 192 square miles of watershed tributary to the Esopus at Coldbrook. The flow, therefore, at Glenerie should have been somewhat less than the flow at Coldbrook, and this flow would be entirely independent of any alleged leakage from the Ashokan reservoir."

The original *Herald-Tribune* story contained nothing to support its statement that its conclusions were "the substance of competent engineering opinion." A follow-up story on Oct. 26, in the journal named, contained denials from Mr. Merriman and Mr. Brush of material leakage and statements from two or three other engineers, only one of whom was cited by name, to the effect that leakage from such a reservoir is possible but improbable in this case. The engineer named was Ford Kurtz, of the J. G. White Engineering Corporation, New York City, who is represented as having "also agreed" (using the newspaper language) "that the theory of flow leakage was not an unreasonable or illogical explanation," but he was inclined "to believe it improbable in the light of his knowledge of such enterprises." To this Mr. Kurtz added the declaration that the Catskill Valley "floor is a strata of igneous rock, the finest bed possible for reservoir purposes."

On Oct. 26 Mayor Walker requested J. Waldo Smith, formerly chief and now consulting engineer of the Board of Water Supply, to report on the alleged leakage.

The average rainfall in the Ashokan water collecting area compared with that in Central Park, New York City, since July 1, 1926, as given to us by Mr. Brush, was: July, 3.65: 6.25; August, 4.84: 712; September, 3.16: 4.72; October (to Oct. 26) 3.74: 4.10; total 15.39: 22.19. The Ashokan or Esopus Creek figures are averages for ten stations, except that the October figure is for Brown's Station alone. The New York rainfall was not only 45 per cent in excess of the Esopus for the nearly four-month period, but it was much more concentrated; or in other words, the Esopus precipitation was so scattered as to lessen the amount that got to the Ashokan reservoir. These rainfall figures are offered for the benefit of any who, like the *Herald-Tribune* story writer, may have been confused by reports of low flows into the Ashokan reservoir when there has been so much rain in New York City for weeks past.

Plan Grade Revision in Colorado

The Denver & Rio Grande Western Ry. is making surveys for grade and line revision at the Cumbres Pass, in western Colorado, to supplement a survey made some ten years ago.

Dr. Humphreys Resigns Presidency of Stevens Institute

Dr. Alexander C. Humphreys, for almost 25 years president of the Stevens Institute of Technology, Hoboken, N. J., resigned on Oct. 21, his resignation to become effective June 5. Anson W. Burchard, vice-chairman of the board of the General Electric Co. and chairman of the finance committee of the Stevens trustees, presided at the special meeting at which Dr. Humphreys presented his resignation. Dr. Humphreys has agreed to take the chairmanship of the board of trustees upon his resignation as president of the Institute.

In recognition of Dr. Humphreys' long service, the trustees voted him a retiring allowance to supplement that which he will get from the Carnegie Foundation. The board also adopted resolutions in recognition of Dr. Humphreys' service at Stevens Institue and to the engineering profession.

Dr. Humphreys had a brilliant career in the public utility field, almost exclusively having to do with the development of gas companies, prior to his acceptance of the presidency of Stevens. The acceptance of the presidency on his part did not deter him from pursuing research work in the field of gas illumination and a part association with companies which he had been largely instrumental in fortifying. His largest executive position before accepting the presidency of Stevens was held with the United Gas Improvement Co. of Philadelphia, where he was first superintendent of construction and later manager of all the company's works. During his association with this company the physical property of the company was quadrupled.

Tennessee Receives Bids on $3,000,000 of Road Projects

Bids were opened Oct. 22 by C. N. Bass, Commissioner of the Department of Highways and Public Works, Tennessee, for approximately $3,000,000 worth of highway construction, before an assemblage of more than 300 contractors, material salesmen, and representatives of bonding companies. Reading of the bids and their tabulation occupied only four hours.

Thirteen states were represented by the bidders: Tennessee, Virginia, Georgia, North Carolina, Kentucky, Alabama, Indiana, Ohio, Illinois, Wisconsin, South Carolina, Oklahoma, and Arkansas. The bids were well distributed, the two highest number of bids on any one project being 16 each. The lowest number on any one project was three.

Engineers to Report on Highway Bridge at Louisville

Ralph Modjeski of New York City and F. M. Masters of Harrisburg, Pa., have been retained to prepare a preliminary report for a highway bridge over the Ohio River at Louisville, Ky. The location has not as yet been finally determined. Field surveys are now just completed. The estimated cost is between $4,000,000 and $5,000,000.

WASHINGTON NOTES

PROSPECTS favor the housing of the Patent Office in fireproof and thoroughly modern surroundings in the new building of the Department of Commerce. The Fine Arts Commission has expressed some fear that a building sufficiently large to accommodate the entire department under one roof would be too massive to fit into the plan for a symmetrical group of buildings between Pennsylvania Ave. and the Mall.

Because of their belief that proper facilities never could be provided in the present building, Secretary Hoover's committee on Patent Office Procedure favors moving the establishment. The National Association of Manufacturers and the U. S. Chamber of Commerce concur in that view.

THE Federal Power Commission has authorized a preliminary permit for the city of Seattle covering a proposed development on the Skagit River in Whatcom County, Washington. The project is intended to utilize effectively the entire head of the Skagit River between the Canadian boundary and the city's constructed gorge power house. The estimated capacity of the entire project is 260,000 hp. which is to be developed in three stages as the needs of the city require. The permit is to contain a provision that water must be stored in such a way as to prevent floods below the dam.

A license has been authorized for the Carolina Power and Light Co., of Raleigh. This license covers a project on Big Pigeon River in Haywood County, North Carolina. The preliminary permit covering this project was issued March 4, 1924, to the Pigeon River Power Co., which turned it over to the licensee. It is proposed to construct a concrete arch dam 130 ft. high, to be raised later to a height of 180 ft. A conduit six miles long will carry water to the power house where 35,000 hp. is to be installed initially and 70,000 hp. ultimately.

HARRY E. Halliday, of Cairo, Ill., has been appointed a member of the Advisory Board of the Inland Waterways Corporation. He succeeds the late Milton H. Hunt, of Memphis.

Mr. Halliday is engaged in extensive business operations in Cairo and was appointed by the Secretary of War on representations made by most of the civic associations interested in transportation on the Mississippi and Ohio rivers. The other members of the Advisory Board are: James E. Smith, St. Louis; Wilmer Jacoby, Pittsburgh; R. A. Brown, Birmingham; M. J. Sanders, New Orleans, and S. S. Thorpe, Minneapolis.

ACTION on the application of the Pigeon River Power Co. probably will be taken at a meeting of the Federal Power Commission set for Oct. 28. The application of the Sierra and San Francisco Power Co. covering a project on the Stanislaus River in California also will be taken up.

President Approves Vale Project for Construction

President Coolidge has approved plans for the construction of the Vale reclamation project in Oregon, the estimated cost of which is $3,590,000. The President's approval is based on Secretary Work's recommendation that the project be allowed. In his report to the President upon the project, Secretary Work cites, in accordance with a provision of the Reclamation Act that "the cost of construction will probably be returned to the reclamation fund. This is interpreted to mean that it will be returned within the period fixed in the contract with the Vale Oregon Irrigation District, which is in forty years from the time the public notice that the works are completed is issued by the Secretary.

"The average construction cost is estimated at about $125 an acre, making the yearly construction payment about $3.10 an acre. The estimated yearly crop income is $37.50 an acre. It would seem that this would enable construction and operating cost to be paid without hardship to the settlers."

Western Pennsylvania Engineers to Hold All Day Session

The civil section of the Engineers' Society of Western Pennsylvania will hold a conference Nov. 4 at the William Penn Hotel, Pittsburgh. The conference is scheduled to open at 9:30 and continue to 4 in the afternoon. At the morning session two papers will be read, one on "Evolution of Steel Skeleton Type of Building" by Robins Fleming, structural engineer of the American Bridge Co., and "Recent Development of Rolled Structural Sections," by A. E. Crockett, manager, bureau of instruction, of the Jones & Laughlin Steel Corporation of Pittsburgh. During the afternoon session two papers also will be read and discussed: "Foundations," by George R. Johnson, vice-president, the Foundation Co., Pittsburgh, and "Effect of Gunite Encasement on Structural Steel," by B. C. Collier, president of the Cement Gun Co., Inc., of Allentown, Pa.

An informal dinner and entertainment will be held in the evening.

Colorado Compact Reservations Not Removed by California

At the special session of the California State Legislature that met Oct. 22, having been called for the express purpose of ratifying the six-state Colorado River compact, the vote was overwhelmingly against withdrawing the reservations. The governor's plea for unconditional ratification was beaten by a vote of 34 to 3 in the senate and 68 to 8 in the assembly. Instead of acceding to the governor's request a joint resolution was passed reaffirming the reservations to California's acceptance of the compact that were adopted by the 1925 legislature. A brief resumé of the situation leading to the call for the extra session was published in *Engineering News-Record*, Oct. 21, p. 681.

RANDOM LINES

How They Do in Germany

Germany now is proud of having also its city traffic problem. Look how they have made it! They have seen the American traffic and whilst they don't have anything like this, they'll have at least an American traffic control. In the cities, big and small, at every road crossing, red and white arrows and other lovely things recently have been placed to explain to all the world how dangerous traffic here will be and how high authorities busily take care to control it. Come here and see it, but leave your motor car in America. It is dangerous here for you: The new traffic-posters are too numerous. One might run against them. FL.

Berlin, Germany.

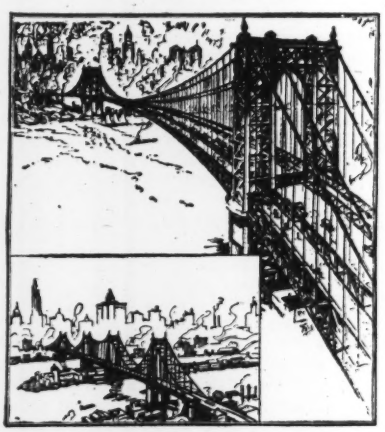
* * *

A Lady Reporter Discovers Some New Things About Electricity

"Through the use of hydro-electric power a wide channel of sanitation has been opened through the entire state. It would of course be impossible to even attempt estimating what this has meant to the health of the people. Hydro-electric power has brought not only industry and wealth but, of greater value, happiness and health.

"Great as has been the development of electric power in North Carolina we are yet a long way behind New England. There, electricity is used more universally for power, light and for transportation. Their colder climate gives them one great advantage. Theoretically the only limit of the work which the electric motor can perform is that which will melt the insulation around the wires; so the lower the temperature the more work the motor will do. With cheap power from the lakes and streams of northern New England one sees visions of electrically operated railroads which can defy the temperature and perform more work even in zero weather."—Annie Leo Graham, in the Greensboro, N. C., *Daily News*.

"Suspension Bridges"



Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

FIFTH ANNUAL ASPHALT PAVING CONFERENCE, AUSPICES ASPHALT ASSOCIATION, New York City, Washington, D. C., Nov. 8-12, 1926.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, Columbia, S. C.; Annual Convention, Philadelphia, Pa., Nov. 15-16, 1926.

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 19-21, 1927.

The Association of Public Works Contractors of Western Washington, newly organized, at its first meeting in Seattle, Oct. 11, elected R. G. Stevenson, contractor, Seattle, president; John Otteson, Seattle, vice-president; Peter Moceri, Seattle, secretary, and Louie Dowell, Seattle, treasurer. About 40 paving, grading and sewer contractors were in attendance.

The Detroit Engineering Society at its Oct. 22 meeting had an address by C. M. Burton, city historian, on the history of land subdivisions in the city of Detroit.

Western Society of Engineers, Chicago sent a delegation Oct. 8 to visit the plant of the Allis-Chalmers Manufacturing Co. at Milwaukee, Wis., being joined by the local engineers society.

Personal Notes

EDWARD H. BENNETT, of Bennett, Parsons & Frost, Chicago, and formerly a director of the National City Planning Institute, has been appointed by Secretary Mellon as consulting architectural specialist for the public buildings work in Washington, D. C. Mr. Bennett has been consultant on many city planning projects and is now civic planning architect of the Chicago planning commission.

REEVES J. NEWSOM, who was connected with the water-works department of Lynn, Mass., for the past fifteen years, has resigned as water commissioner there to become vice-president of the Community Water Service Co., which owns water-works in several cities in Missouri, Illinois, New Jersey, New York and Pennsylvania, and will as a water-works engineer direct a portion of the properties of that company and will have connection with the purchase of additional systems.

NATHAN H. STURDY, formerly chief engineer and consulting engineer for the Truscon Steel Co. at Youngstown, Ohio, and recently connected with the Buffalo office of that company, has severed his connections with the company and announces the opening of an office for practice as a consulting engineer at 1000 Prudential Building, Buffalo, N. Y., specializing in fireproof structures.

R. MARVIN PORTER, formerly with the highway department of South Carolina, has been appointed city engineer of Columbia, S. C., succeeding W. S. TOMLINSON, who served as city engineer of Columbia five years, but resigned to devote his time to the interests of the Tomlinson Engineering Co.

COL. WILLIAM KELLY, Corps of Engineers, who has been director of engineering for the National Electric Light Association, resigned recently to become vice-president of the Buffalo, Niagara & Eastern Power Corporation, in charge of engineering and operation. Colonel Kelly served for more than four years as chief engineer of the Federal Power Commission; he is a member of the American section of the Joint Engineering Board on the St. Lawrence River, has made detailed studies of the Colorado River and other waterways, and for four years was assistant to the Chief of Engineers at Washington, D. C., in charge of rivers and harbors work. During the War Colonel Kelly was chief engineer, first, of the 42nd Division, and then of the Fourth Army Corps, and later commanded base sections 7 and 9; after the War, in duty for the American Peace Commission, he made a reconnaissance of five rivers internationalized by the treaty of Versailles.

MAJOR HOWARD S. BENNION, Corps of Engineers, who succeeds Colonel Kelly as director of engineering of the National Electric Light Association, was assistant chief engineer of the Federal Power Commission from 1920 to 1924, and since 1924 district engineer of the Fourth Mississippi River Commission, at New Orleans. He also was in active service during the War and in 1919 was in charge of road work in some sections of the battle area.

PAUL S. CLAPP, who has been special assistant to Secretary of Commerce Hoover in engineering, economic and commercial problems of the United States, who had extensive experience in Europe after the War as administrator and in electrical and power engineering, has been appointed executive head of the National Electric Light Association.

Obituary

JAMES A. FRENCH, state highway engineer of New Mexico, died at the steering wheel of his automobile twenty miles from Encino, N. M., Oct. 14; a friend with him took the car in charge. Mr. French was returning from inspection of mining property at Corona, N. M. He was born in Washington, D. C., in 1866, and educated at Georgetown University. He served with the U. S. Coast and Geodetic Survey and in the U. S. Reclamation Service, and had been state engineer and state highway engineer in New Mexico since 1912 except for three years spent in private practice.

CARL F. HEINTZE, contractor and engineer, Sacramento, Calif., died Oct. 11. Besides engineering and construction work in other fields, Mr. Heintze was a superintendent of construction and assistant division engineer for the California State Highway Commission and assistant highway engineer for Sacramento County. In his private work he specialized in bridge and highway construction. It was while he was superintending the construction of a bridge across the Truckee River at Hinton that he was stricken was pneumonia, following which he was taken to Sacramento and died there. Prior to going to California he was assistant chief engineer of the Hilo Railway Co. in Hawaii and earlier had been sanitary inspector in the Canal Zone. During the War he was a lieutenant in the engineering corps.

HARLAN D. MILLER, bridge engineer of the California Highway Commission, died Oct. 20 after a prolonged illness. He was a graduate of Case School of Applied Science, class of 1904, and in the early years of his professional career was successively with the J. P. Cowing Co., contractors, Cleveland, Ohio; the bridge department of the New York Central R.R., and the New York State Engineer's office. After four years in the latter position he became head of the bridge department where he had charge of the preparation of plans for some 300 state highway bridges. In 1915 he became a partner in the firm of Watson, Davis & Miller of Cleveland and opened an office in San Francisco where he proposed the construction of a bridge across the bay connecting San Francisco and Oakland. In 1919 he was appointed assistant bridge engineer with the California State Highway Commission and in 1924 succeeded H. E. Warrington as chief bridge engineer which position he held until his death. The Commmission has announced that the 234-ft. arch bridge now under construction over Dog Creek, the highest and longest concrete arch in California, will be named in memory of Mr. Miller.

SAMUEL P. HARRIS, for many years county surveyor of Shelby County, Indiana, died recently at the home of his daughter in Shelbyville, Ind., after an illness of two months.

Construction Equipment and Materials

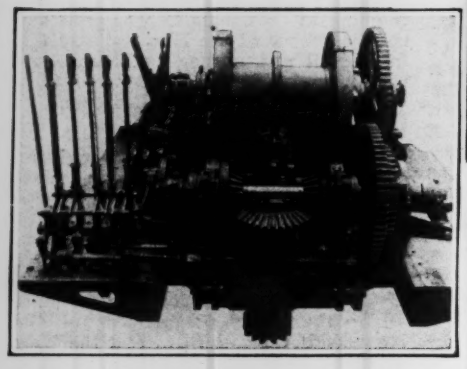
A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

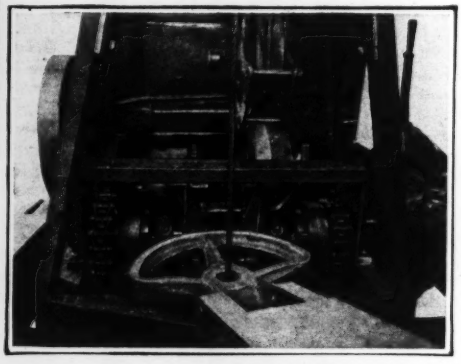
Lubricating Construction Equipment

With Special Regard to Cold Weather Practice on Bearings, Wire Rope, Gears and Internal Combustion Engines

By Allen F. Brewer
Mechanical Engineer, Texas Company, New York City

THE RELATIONSHIP between efficient machine operation and the volume of materials that can be handled by construction machinery is not only a job of production. Quite as much does it involve maintenance of such equipment as power shovels, ditchers, backfillers, dragline scrapers, and concrete mixers. Always tied in closely with maintenance is the question of proper lubrication, one of the subjects to which many contractors do not give enough serious study, possibly because the ruggedness with which many of the machines are built and the efficient manner in which they operate for a time without special attention to lubrication, reduces any tendency toward "coddling" on the part of the operator. This article is intended to point out the proper oil to use, based primarily on viscosity, which gives a common basis on which to purchase oil, regardless of course of what company produces it. Viscosity is explained and considerable attention is paid to cold weather oils for use on construction equipment.





Some Machine Details Upon Which Better Lubrication Means Greater Output and Longer Life

The Meaning of Viscosity

Practically all construction machinery involves operation in and exposure to dust, dirt, rain, snow and frequently acid or alkali fumes. Corrosion and abrasion between wearing elements will therefore tend to occur to a marked degree. The fact that this holds true regardless of whether gears, bearings, wire rope or engine cylinders are involved, renders it difficult to discuss the lubrication of any of these parts from a priority point of view. They are all important. Before going into detail in regard to the oil to be used on different types of equipment a word of explanation in regard to viscosity, the rule by which most oils are measured, will be of interest.

Viscosity as understood by those dealing with lubrication, is a measure of the comparative fluidity of any lubricant. The wide difference in service and operating conditions calls for a wide range in available viscosity, extending from oils similar to kerosene to the semi-inert gear lubricants. To select intelligently any lubricating oil from this wide range, it is essential to have an understanding of at least that particular test which is so extensively used in defining the body of an oil and judging whether it is suited to the operating conditions involved.

Viscosity can be measured by a number of types of instruments known as viscosimeters. Generally the Saybolt universal viscosimeter is used in the United States. Viscosity can be measured at any temperature, provided the oil to be tested is not too heavy or too fluid. As a rule 70, 100, 130 or 210 or 212 deg. F. is the best temperature; 100 and 210, however, are those most commonly used.

The principle of the Saybolt viscosimeter involves the length of time required for 60 c.c. of any fluid to flow completely through a standardized orifice. The number of seconds required is noted as the viscosity Saybolt at the particular temperature of observation. The relative fluidity of the oil to be tested will be the best guide as to the temperature to select. Too much or too little time should not be involved. Therefore, 210 deg. F., for example, is chosen as the temperature of test for gear, chain and wire rope lubricants, steam cylinder oils and extra heavy internal combustion engine lubricants. One hundred deg. F., on the other hand, will be satisfactory for testing machine and engine oils, and other lighter bodied products. In the accompanying table are given recommendations as to the type of oil to be used on different pieces of construction equipment, the type of oil being determined by first viscosity in seconds Saybolt and in pour test range. The latter is only important for winter service.

Gears and Chains—Gears and chains probably give the longest service under faulty conditions of lubrication. Although they are very frequently in an exposed position and thus difficult to keep lubricated with oils not contaminated with dirt and foreign matter, nevertheless to neglect them altogether is bad practice, even though effective lubrication may be a problem.

In general, periodic cleaning of the wearing elements and treatment with a straight mineral gear lubricant having a viscosity of from 1,000 to 2,000 Seconds Saybolt at 210 deg. F. will insure continued service and be most satisfactory. Lubricants of this nature are highly adhesive and effectively resist the washing-off action of water or the penetration of abrasive foreign matter.

Wire Rope Lubrication—For wire rope to function effectively, it should be lubricated with care, for when dragged through dirt, sand, etc., a certain amount of such material is bound to penetrate within the strands; an effective lubricant will protect the strands against an excessive penetration of such foreign matter. Furthermore, it will prevent entry of moisture and consequently, rusting and corrosion, at the same time acting as a friction-reducer.

A wire rope lubricant will give the most satisfactory results provided it is insoluble in water, of a non-hardening and non-caking nature regardless of the temperature, and of sufficiently high viscosity to resist mixing with foreign solid or fluid matter. It should also not tend to squeeze out from between the strands or drip from the rope

under high temperatures, and it should be of such a nature as to permit of proper application either by brush or split box without the necessity of excessive heating. The ideal wire rope lubricant is a straight mineral product of the distillation of crude petroleum. The requisite viscosity will be from 500 to 1,000 Seconds Saybolt at 210 deg. F. Such an oil should not be contaminated with filler such as talc or soapstone or contain any acid or alkali. These latter lead to ultimate corrosion, especially on the surfaces of the inner strands.

Steam Cylinder Lubrication—Steam operated machinery will frequently involve quite a problem as cylinder and line condensation tend to hamper effective lubrication. Tendency toward condensation can be reduced by taking the steam from the highest part of the boiler and by using insulating pipe covering. Intermittent operation is very conducive to cylinder condensation.

The selection of cylinder oils for such service requires special attention, therefore, to their extent of compounding for an emulsifiable constituent is necessary to give the requisite adhesiveness to the lubricating film on the cylinder walls and valve seats. Only in this way can the water be counteracted. Steam refined cylinder stocks are comparatively tenacious in themselves and under dry steam conditions will normally give satisfactory results. The addition of from 6 to 10 per cent of fatty (animal) compound such as degras, lard oil, tallow, etc., will increase this characteristic to a marked degree.

The method and point of delivery of cylinder oils to the steam lines leading to the respective engines must of course be given proper attention. It is not enough to simply see that oils of the proper specifications are used. They must be delivered by suitable lubricating equipment of either the hydrostatic or mechanical force feed type, via properly constructed atomizers inserted in the steam lines at a distance of from 4 to 6 ft. back from the throttle valves. This will insure the requisite degree of atomization of the oil prior to its entry into the engine along with the steam.

The mechanical force feed lubricator is the more positive device for it requires less manual adjustment than does a hydrostatic device. Furthermore, it only operates when the engine does, and at a speed dependent upon the speed of the latter. Marked economy is thereby possible if the lubricator is regulated to deliver oil at the required rate for full-load-speed conditions.

Internal Combustion Engines—The use of the gasoline and kerosene engine was in many ways a boon to the operator from a lubricating point of view. Such engines are practically all equipped with means for automatic lubrication of either the splash or force feed type.

Oils of specifications similar to those used on the average automobile engine are adaptable and applied in much the same manner. It will be advisable in this respect to know the engine builders' recommendations or oil charts when selecting an oil for such service, especially if the lubricating system is at all unique, or if climatic conditions vary to any extent. The only other requisite is to maintain the oil at the right level in the crankcase and drain it at periodic intervals. The custom of many tractor operators may be of value in this regard, i.e., to drain and change oil every 40 to 50 operating hours according to whether kerosene or gasoline is used as fuel.

Bearing Lubrication—In this regard we will be primarily concerned with the external bearings of construction equipment. Here again because of the operating conditions, the average operator will be very apt to overlook the importance of lubrication with the idea that it is more or less of a hopeless job anyhow. Machine builders have, however, appreciated this and as a rule provided their power shovel bearings, etc., with adequate means of lubrication in the form of oil or grease cups, or pressure grease appliances. Furthermore, there are oils and greases available at a reasonable price which will adequately protect the bearings if properly applied by the lubricating equipment at hand. Recommendations as to the type of oil to use on different bearings are given in the accompanying table.

LUBRICATION RECOMMENDATIONS FOR CONSTRUCTION MACHINERY

Part to be Lubricated	Viscosity, Seconds Saybolt—Summer	Viscosity, Seconds Saybolt—Winter	Pour Test Range for Winter Service
Gears—Exposed or merely guarded	2,000 at 210°	1,000 at 210°	
Gears—Enclosed, where bath lubrication is possible	1,000 at 210	115 to 200 at 210	15° F. or lower
Wire rope	1,000 at 210	500-600 at 210	
Chains—Roller type usually exposed	1,000 at 210	500-600 at 210	
Chains—Silent or link type			
Exposed	115-120 at 210	70-80 at 210	10° F. or lower
Enclosed	70-80 at 210	55-60 at 210	0° F. if possible
Steam Cylinders	130-150 at 210	120-130 at 210	As low as possible
Link pins and rollers of caterpillar tractors	200 at 210	115 at 210	15° F. or lower
Internal combustion engines	See recommendations of builders and oil companies, according to type and size of enginesand fuel used		0° F. if possible
Electric motors			
Ring oiled bearings	300 at 100	180-200 at 100	0° Fahr.
Ball and roller bearings			
Oil lubricated	150-200 at 100	100 at 100	0° Fahr.
Grease lubricated	A grease of light or medium consistency		
Journal boxes	100 at 210	60 at 210	15° Fahr. or lower
Miscellaneous other bearings			
Oil lubricated	300-500 at 100	200-300 at 100	0° Fahr.
Grease lubricated	Medium cup grease	Light cup grease	

Cold Weather Service

The extent to which construction equipment is used in cold weather warrants special attention to the matter of selection of lubricants adaptable to the low temperature conditions involved. The machinery must normally function in the open and with but little chance of protection in the way of heating. Not only must oils and greases be of such characteristics as to be readily handled, but also they must be capable of flowing to the innermost surfaces of the wearing elements under the action of gravity or the available pressure.

In the case of products such as lubricating oils, wire rope and light gear compounds, which are comparatively fluid at normal room temperatures, it will be important to investigate both the viscosity and the pour test. It is these characteristics converted to or observed at the probable temperatures of operation which will be indicative of the degree of fluidity of any lubricant under such conditions, and a guide as to the extent to which it will lubricate effectively. Simply because it may be practicable to store and handle such products in a steam-heated building is no reason for neglecting to investigate their viscosity and pour test at zero or whatever probable outdoor temperature they may be used under.

Refinement Important—The paraffine base product unless subject to a careful process of refinement to bring about the removal of the greater part of its paraffine content, will tend to congeal at temperatures all the way from 20 to 60 deg. F., depending upon its viscosity, as for example, the average steam cylinder oil which is frequently used to lubricate enclosed gears and chains. With a pour test of from 45 to 60 deg., it is evident that for the latter purpose in zero weather such a lubricant might easily become so sluggish as to fail to give the necessary lubrication. In addition it would impose more or less of a drag on the working elements with which it comes in contact. So the use of such a product with a misguided idea as to the economy in the number of products stored might easily lead to subsequent trouble through abnormal wear of chain links, gear teeth or bearings.

In the case of engine or bearing oils of lighter viscosity or body, this factor of possible congealment would of course not be so important, except under conditions of operation below, say, 10 deg. F.

Internal Combustion Engines—The extent to which the internal combustion engine has been adopted on construction machinery makes the lubrication of it a very important question to contractors. Such engines of course start cold, that is, the oil in their crankcases is down to atmospheric temperature after a night, or even an hour or two of idleness. It is absolutely imperative that this oil be sufficiently fluid to be pumped or otherwise distributed by the lubricator immediately

the engine is turned over. With the automobile, the utmost care should be used to select winter lubricants which will have a sufficiently low pour test to insure perfect flow and lubrication at the first revolution of the engine.

Wire Rope and Gearing—The lubrication of wire rope and exposed gearing in cold weather can in general be done at such a time when the lubricant can be heated sufficiently to enable ready application by hand or otherwise. As previously mentioned, the lubricant must be adhesive and of comparatively high viscosity. As operating temperatures increase, naturally these characteristics will become greater. Wire rope and gear lubricants should therefore for cold weather service be of lower viscosity. In other words, while a wire rope lubricant of 1,000 Seconds Saybolt at 210 deg. F. would be advisable for summer service, in the winter this viscosity should be in the neighborhood of 500 to 600 seconds. This difference in type of oil used in summer and winter is shown in the accompanying table. For exposed gears, a product of approximately 1,000 seconds viscosity would be advisable in cold weather.

The matter of pour test, in the case of such products, cannot be so readily discussed. In fact, they cannot be stated to have a definite pour test. If properly refined, however, and of a naphthenic base, they will not tend to congeal or solidify as paraffine would but rather will become more sluggish and with usually a high degree of adhesiveness.

An important factor in this matter of selecting such higher viscosity lubricants is to bear in mind that in proportion to decrease in operating temperatures, there will naturally be more of a drag or braking effect exerted between the gear teeth or the strands of wire rope in operation over drums or sheaves. This is frequently a guide as to the suitability of such a lubricant to the service involved. The remedy, of course, is to decrease the viscosity by using a lighter product.

Greases—The selection of greases for cold weather service requires attention to both their consistency and to the base of the oil which has been used in their manufacture. Greases are marketed in more or less standard ranges of consistency, being numbered in many cases to indicate this property. Where, therefore, a No. 5 cup grease of any specific manufacturer would be adaptable to warm weather service in compression cups, in cold weather a No. 3 or No. 1 would probably be advisable.

Greases, however, are only as effective as the oils which are used in their manufacture, for it is these latter which actually do the work of lubricating. Grease containing a low pour test oil should therefore be used for conditions of extreme cold. Otherwise, natural congealment might easily preclude lubrication until the bearings have developed sufficient friction to raise their temperatures and render such a lubricant of the requisite fluidity. This may involve metallic friction to such an extent as to give rise to considerable wear.

Conclusion—It is therefore important for the purchasing agent or contractor to not only give attention to the selection of the lubricants in summer, but also and more so in cold weather. In fact, there is no excuse for his purchasing unsuitable lubricants today because the lubricating engineers of all the reputable oil companies are available for consultation and advice in this matter.

Cash-Basis Business Permits Lower Equipment Prices

Sir—This year we developed a new method of selling our equipment which we thought might interest other manufacturers, as it has worked very satisfactorily, both for ourselves and for the contractors.

On Jan. 1 we found we had over $100,000 of frozen assets against contractors who were unable to pay because they had not finished their contracts. This amount was on our books in spite of the fact that we had employed a collector for a number of years, whose salary and expenses aggregated about $5,000 annually. Consequently on the first of the year we decided our terms to contractors would be "cash with order." For the first eight months our sales ran nearly a quarter of a million dollars ahead of any previous year. Thus by eliminating the losses on poor accounts, expenses of collection, etc., we were able to lower our prices enough to get this increase in business. In addition we have obtained the good will and cooperation of responsible contractors who tell us that by our action in not trusting and thus financing a lot of "shoe string" or unresponsible contractors, we have enabled the responsible contractor to obtain contracts at living profits. We believe if all manufacturers' salesmen would adhere strictly to these terms that 90 per cent of all failures of both contractors and manufacturers would be eliminated.

Charlotte, Mich., Oct. 11, 1926 — F. H. BEACH, Beach Mfg. Co.

Preliminary Plans for Chicago Road Show Completed

The 1927 Convention and Road Show of the American Road Builders Association will be held in Chicago January 10-14, inclusive. As usual, the Road show will be held in the Coliseum, but the convention and headquarters will be at the New Palmer House. Official headquarters will be opened there December 10, 1926.

A program has been arranged consisting of two sections, one for engineers and officials and the other for contractors, manufacturers and material producers. The chairman of the program committee is H. K. Bishop of the Bureau of Public Roads, and he has assisting him S. M. Williams of the Autocar Co., in charge of the contractors' program and Paul Tebbs of the Pennsylvania State Highway Department in charge of the engineers' program.

Two special days have already been designated "Governors' Day" and "Pan-American Day." At the annual banquet it will be possible to provide for 2,000, whereas the number was limited to 1,200 last year. No speaker has as yet been secured.

It is said that already applications for space at the Road Show have exceeded those of last year. The Coliseum committee will be headed by J. E. Tate of the Portland Cement Association.

It is announced that reduced railroad fares will be granted this year only to members, whereas formerly they were available to all delegates. Additional information may be had from the business director, Charles M. Upham, Raleigh, N. C.

New Publications

Voltmeters—BRISTOL CO., Waterbury, Conn., has issued a new catalog describing its recording voltmeters. The catalog is No. 1502. It contains illustrations and descriptions of various types of voltmeters using both round charts or strip charts.

Hydraulic Dredges—NORBOM ENGINEERING CO., Darby, Pa., has made available a 25-p. catalog describing its hydraulic dredges. Sections of the catalog each containing illustrations and descriptive information, are devoted to the pumping machinery, the winding machinery, the cutter machinery, the fittings, and the pipe couplings.

Bar Benders—KARDONG BROS., INC., Minneapolis, Minn., devotes its catalog No. 26 to its many models of machines for bending reinforcing steel. These are belt driven, motor driven, gear driven and manually operated.

Rock Drills—CHICAGO PNEUMATIC TOOL CO., New York City, devotes Bulletin 851 (first edition) to its C.P.-5 Drifter. A discussion is given of the advantages and a few cases cited of the performance of this equipment. The different types are illustrated and described, specifications being given for all accessories as well as the machine itself.

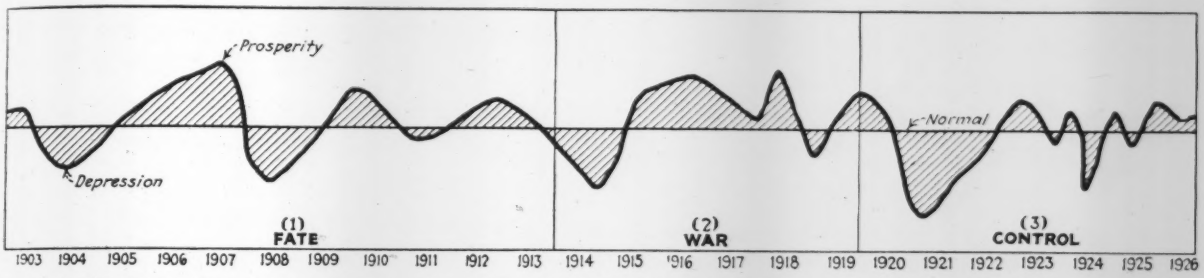
Tractor Equipment—LAPLANT-CHOATE MANUFACTURING CO., Cedar Rapids, Iowa, has issued a 32-page catalog containing illustrations and descriptions, including machine details and construction views of the several types of equipment that it manufactures for tractor attachment. Such equipment includes dump wagons, bulldozers, hydraulic scrapers, trailers, platform trailers and snow plows.

Gas Engine Lubrication—CLIMAX ENGINEERING CO., Clinton, Iowa, is distributing a revised edition of its booklet of instructions for the lubrication of its heavy duty medium-speed industrial engines. The book was originally prepared by the technical staff of the Vacuum Oil Co. in collaboration with engineers of the Climax Engineering Co. Information is given on the type of oil to use, the method of using it both in hot and cold weather and other suggestions designed to produce more efficient and economical operation.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Evolution of Business



(1) "FATE"—Before the great war the business world was bound by the superstitions of cause and effect, supply and demand, and that the full dinner pail must inevitably be succeeded by the partly-filled dinner pail. Reliable statistics, especially in the construction industry, had never been heard of, and had they been nobody would have listened to them. The philosophy of that era was: "What comes must come." The dark age of business was broken up by the electric storm of 1907, followed by the Federal Reserve rainbow.

(2) WAR—Such figures as were compiled during the period covered by 1916 to 1920, naturally have to be omitted from any long-time survey.

As far as business statistics are concerned, war is only an alias for chaos.

Over the gradually rising secular curve of sound business, the war peaks tower as mountains of smoke. They denote price inflation and frenzied production to meet an utterly antique demand.

(3) CONTROL—Jobbers and dealers used to buy for the future; now they fill the current requirements of their customers and let their own yards and bins lie nearly empty.

Manufacturers used to pile up their products; now they regulate production to immediate demand.

This system alone greatly reduces the likelihood of industrial depressions, as there is nobody to be "stuck" with a husky supply and feeble call for it.

THE FOREGOING is, sketchily, the comparatively recent evolution of business. Just now the construction phase of this business evolution is being studied by *Engineering News-Record*. Construction is a broad term—almost as comprehensive as business in general—hence, all the major classes of the *Engineering News-Record* contract-value statistics from 1913 to date are in process of being analyzed separately.

This work has been undertaken not alone for the economist in the construction industry. Its practical usefulness will extend to the salesmanager as well as to the statistician. It will help all who are sufficiently interested to have read this statement through. *Your* suggestions and comments are earnestly asked.

This Week's Contracts—Week Ago—Same Week Last Year

MONEY value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Oct. 28, 1926	$25,519,000	$41,341,000	$66,860,000
Oct. 21, 1926	21,791,000	41,944,000	63,735,000
Oct. 29, 1925	22,064,000	26,970,000	49,034,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	936,081,000	1,481,097,000	2,417,178,000
1925	906,367,000	1,227,346,000	2,133,713,000

Engineering construction in the proposed stage for the week ended Oct. 21, totaled $105,162,000 as against $61,439,000 for the week of Oct. 14 and $105,518,000 for that of Oct. 7. The drop for the week of the fourteenth occurred in public projects and was also induced, to a certain extent, by the holiday, Oct. 12, 1926.

Colombian Highway to the Sea Awarded to New York Contractors

One of the first important modern highway projects ever undertaken in the Republic of Colombia has been awarded to R. W. Hebard & Co., Inc., of New York, by the Government of the Department of Antioquia.

This project is known as the Carretera al Mar or Highway to the Sea and embraces the construction of a modern motor road from the city of Medellin, capital of the Department of Antioquia, to the Atlantic seaboard at some port along the Bay of Uraba, which will be decided on later.

The total distance to be traversed is approximately 300 kilometers, the route lying in one of the most mountainous regions of the Republic and crossing the Eastern Cordillera at an elevation of 7,500 ft. above sea level.

Ten other foreign jobs have gone to American firms since Jan., 1925.

If you are in the market for new machinery, equipment, materials, see page 73 of Construction News.
KEEP TURNING TO THE RIGHT→

Weekly Construction Market

JUST about an even half of the basic materials used in all forms of construction show price declines compared with a year ago this week.

Average prices of the various materials in the eight great industrial districts of the country were used in making this comparison.

The declines in the order of their importance are as follows: Linseed oil, 10.8 per cent; sand and gravel, 7 per cent; reinforcing bars, 5.5 per cent; structural rivets, 1.8 per cent; crushed stone, 1.7 per cent; cast-iron pipe, 1.1 per cent.

The comparison reveals advances in the following materials: Lime, 4.6 per cent; brick, 3.1 per cent; hollow building tile, 2.9 per cent; wrought-steel pipe, 1.7 per cent; lumber, 1.3 per cent. Warehouse prices of structural steel shapes and dealers' cement quotations remain at exactly the same levels as at this time in 1925.

Mill prices of the principal heavy-rolled steel products, compared with a year ago, reveal a slightly different situation from that prevailing at dealers' warehouses in the various cities throughout the country.

While the dealers' prices of steel shapes are unchanged, the minimum on this material at Pittsburgh mills is 5.2 per cent above the level of Oct. 29, 1925. The minimum on plates is 5.5 per cent higher at Pittsburgh, while reinforcing bars hold firmly to the mill price quoted exactly one year ago.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	3.38	2.25@2.40	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	51%	54.25%	41%	49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@52.60	45.25	54.00	48.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	58.25	38.75	34.75	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.088	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.088	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	+ .87	.99¾	1.10	.88	.94½	1.08	1.01	1.12	1.05
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	.90	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.60	.40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90½c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Oct. 7 the next on Nov. 4.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.125). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) carload lots; shapes, l.c.l.

Business Briefs

Call money quoted at 4½ per cent, Oct. 25; year ago, 5 per cent.

Time loans: Sixty to ninety days, 4½@5; four to six months, 5 per cent.

Commercial paper: Best names, 4@6 mo., 4½; others, 4¾ per cent.

On Oct. 1, 1926

E. N.-R. Construction Cost Index Number 209.80

E. N.-R. Construction Volume Index Number 227

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month